Lieutenant A and the rottweilers.

A Pheno-Cognitive Analysis of a fire-fighter's experience of a critical incident and peritraumatic resilience.

Paul Théron

Submitted for the degree of Doctor of Philosophy

to

The University of Glasgow

College of Science and Engineering

School of Computing Science

24 April 2014

patheron@wanadoo.fr

"*scientific thinking is viewed as 'intensely solitary and social' at the same time (John-Steiner, 1985[1]). It is analytical; it 'tests the value of an insight – a new pattern or set of connections – for its general concepts. And in the process of testing, other, more complex, anomalous, or disturbing patterns emerge that create a powerful tension between the varied aspects of the enterprise of extending knowledge' (John-Steiner 1985, p. 203). Further, it is characterized by 'logic and metaphor, quick thought and lengthy periods of evaluation' and analogies. In the cultural-historical (sociohistorical) view, this process is called learning by expansion (Engeström, 2000[2])*". Spear-Ellinwood (2008).

SUMMARY

Context, question and goal: Attacks against fire-fighters during interventions in the field, by humans or dangerous dogs, are frequent. They are Critical Incidents (CI) of a psychologically traumatic nature, theoretically capable to affect people's capacity to perform at the *peritraumatic* stage (time of the exposure to trauma, i.e. the intervention). How can fire-fighters manage to resume and complete their mission after an exposure to trauma ?

Method: This research investigates the cognitive process (*Decision-Making-in-Action - DMA*) that controls the reactions and *Peritraumatic Resilience* (*PTR*) of an individual fire-fighter, Lieutenant A, during the experience of a CI in action, an attack by two rottweilers. Pre-traumatic (before the intervention) and post-traumatic (after the intervention) stages of the experience of CIs are out of our scope. To this end we elaborate an ad hoc methodology, *Pheno-Cognitive Analysis* (PCA), a consistent data collection, processing and analysis method allowing to capture retrospectively the subject's first-person narrative of his *episode of individual cognitive experience* and to analyse it. The concepts of the Elicitation Interview (EI) that guides the subject to recall *authentic* (not socially reconstructed) episodic memories of his experience are detailed. All precautions required by the British Psychological Society were taken in order to prevent the risk of causing stress or even more trauma to the subject. In data processing, a semantic analysis of the subject's first-person narrative reveals 460 *cognitive operations* (CogOp), also called decision-making steps (DM Steps) and performed during the 44 *Present Moments* (PM) of the episode, i.e. 44 *narrated decision making cycles*. These 44 PM themselves show that Lieutenant A's experience of the CI was made of 9 *Experience Phases* (EP), phase 3 being the traumatic exposure itself and comprising PM # 11 and 12. *Decision network* models describe statistically each PMs' *cognitive trajectory* and evidence variations of their shape. Data analysis seeks to characterise and analyse these various shapes (*DMA patterns*). It searches for the factors of these variations through the interpretative definition of several categorical and ordinal attributes derived mainly from Lazarus' work on the appraisal and coping mechanism, works on resilience such as Carver et al.'s (1989), also Styles' (1997) analysis of attention, Endsley's work on situation awareness and our prior work on the focus of attention. Three data sets were elaborated: EP data set, PM data set, CogOp data set. Data distributions were not normal and attributes were discretised. An exploratory factor analysis of these data sets was performed. Chi-Square tests, the Goodman-Kuskal's assymetric lambda and Bayesian analyses revealed dependencies between attributes but did

not provide evidence of the factors of variation of DMA patterns. Decision Tree analyses (C4.5 and Random Forest) algorithms were used then to explore the datasets and led to identifying factors and rules of election of DMA patterns and DM Steps in the flow of cognitive operations recalled by Lieutenant A. The exploratory analysis of the CogOp data set helped to characterise the impact of trauma on the subject's ability to perform (*self-agency*) and the *resilience mechanisms* he resorted on in response.

Findings: Seven findings were drawn from the processed data. 1) Four DMA patterns were identified, in which affects play an important part in a third of all PMs. 2) DMA patterns change from one PM to the next (*Inter-Variability*) and a model of inter-variability was elaborated. 3) The shape of cognitive trajectories varies within each DMA pattern (*Intra-Variability*) and rules of production of intra-variability were found. 4) Recognition, memory and metacognition were not found to play a clear part in DMA. 5) CI Experience Phases are resilience-focused turns in the story plot. 6) A CI is an experience of collapse of self-agency. 7) PTR stems both from a cognitive struggle for agency and from external support. A macrocognitive model of Decision-Making-in-Action (DMA Model) is derived from previous analyses and shows the role of affect in the process of individual decision-making.

Discussion: The PCA methodological framework must be first considered from the perspective of its limitations. First, despite precautions taken, no one can guarantee that the subject's recalls are exhaustive and totally veridical to his original experience. Forgetness, voluntary ommissions, and even some forms of social reconstruction are possible. The conduct of the Elicitation Interview is itself difficult. It requires concentration and an assistant researcher could help notice points in the narration that deserve further elicitation. The first-person narrative so obtained may therefore not be as authentic an empirical material as the researcher would wish. Beyond, the processing of the narrative, its chronological reordering and the semantic analysis of each speech clause found in the subject's answers, may be tainted with some faults (mistakes, misinterpretations, forgetness), again despite precautions taken. Finally, the current loneliness of the researcher who embarks on using such a protocol is still such that cross-coding and verification by other researchers and peers is virtually impossible. However, Lieutenant A's case study shows that the PCA protocol yielded a significant number of detailed, usable and fairly reliable data for the exploration and analysis of his individual experience of a specific episode of action. It helps to depict and understand the experience of trauma in action and peritraumatic resilience. It provides useful inputs for improving the

metacognitive training of people potentially exposed to CIs. Two generic skills are revealed : *Individual Resilience Management* and *Collective Resilience Management*. They split into *five elementary metacognitive skills* : situation-shift management, self-regulation conflict management, affect-based decision-making warnings, by-the-second cognitive struggle for self-agency, and attentive crew realignment.

Conclusions and further research: This thesis has introduced a novel first-person methodology, and the findings of Lieutenant A's PCA case study sought to contribute NDM research by studying individual decision-making and the experience of trauma (in contrast to stressful and nominal circumstances) in action. Further research is envisaged : the continuous improvement and validation of the PCA methodology, the development and test of CI metacognitive training schemes to enhance fire-fighters safety, the study of the transition mechanism and rules between cognitive operations. Inputs to the design of cognitively autonomous computer agents for video games and behavioural simulators are also envisaged.

ABSTRACT

Fire-fighters are subject to *attacks* in the field. This idiographic *Pheno-Cognitive Analysis* (PCA) studies a fireman's cognitive experience of a *Critical Incident* (CI) when he is attacked by dangerous dogs during an intervention. The PCA method, created for this research, extends the *Elicitation Interview* (EI), yields a first-person narrative of the subject's experience out of his episodic memory, and semantically elicits 460 *Cognitive Operations* and four patterns of *Cognitive Trajectories*. Their variations in shape (*Intra-Variability*) and occurrence (*Inter-Variability*) are analysed. A model of *Decision-Making-in-Action (DMA)*, and five *Metacognitive Skills* providing *Peritraumatic Resilience (PTR)* are revealed. Epistemological limits are discussed.

STRUCTURE OF THE RESEARCH REPORT

PART 1 : The problem space

Chapter 1 presents a challenge that awaits fire-fighters during their interventions in the field, attacks from people and dangerous dogs, that are deemed to be Critical Incidents (CI). As CIs are of a traumatic nature, **chapter 2** explicits the experience of trauma, in its difference from stress. and its peritraumatic phase. **Chapter 3** presents our research question after defining the concept of peritraumatic resilience (PTR) as the capacity to surmount trauma at the peritraumatic stage own to three coping capabilities, and points to the need to study its underlying cognitive processes. **Chapter 4** presents Naturalistic Decision-Making research (NDM), points to what appears as one of its major findings, the variety of DM strategies. It highlights the fact NDM research ignores the role of affects, defines the concept of Decision-Making-in-Action (DMA) and posits that PTR is a metacognitive outcome of DMA. **Chapter 5** explores metacognition and metacognitive training and presents a framework designed to prepare fire-fighters for CIs. In **chapter 6**, we review the main methods used in NDM research and explain why our research rather turns to a first-person approach. **Chapter 7** presents the epistemological assumptions of phenomenological psychology as it proposes a rigorous method, the Elicitation Interview, to capture the subject's first-person episodic memories of a singular episode of experience. This chapter also defines our research object, the episode of experience, and its subdivision, the Present Moment, made of a sequence of cognitive operations conceived as pairs of {cognitive act ; cognitive object}.

PART 2 : The Research Design

Chapter 8 gives a general overview of the Pheno-Cognitive Analysis (PCA) methodological framework as it resulted from our research work. **Chapter 9** elaborates the guidelines for performing Elicitation Interviews (EI) to help the subject recall authentic cognitions of the actual time of the experienced episode of action under study. **Chapter 10** elaborates guidelines for data processing in the context of a PCA study and presents examples of the cognitive models used to prepare data analysis. **Chapter 11** provides general directions for data analysis, for the discussion of the study's findings, and presents arguments and guidelines for assuring the scientificity of a PCA study.

PART 3 : Data and their processing

Chapter 12 presents Lieutenant A's narrative. **Chapter 13** presents the results of the data processing phase : the structure of the episode of experience elicited from the narrative (Experience Phases → Present Moments → Cognitive Operations), the chronotext i.e. the chronologically reordered sequence of speech clauses, a taxonomy of cognitive acts and objects, the cognigraph i.e. the detailed model of the sequence of cognitive operations performed by the subject during the entire episode, then the decision network models statistically describing the subject's cognitive trajectories along the different experience phases and present moments. Effective precautions and limits in relation to the scientificity of our work are also presented.

PART 4 : Data analysis, discussion and conclusions

Chapter 14 analyses the processed data of Lieutenant A's case and presents our seven findings. **Chapter 15** discusses these results from a metacognitive perspective and presents the general conclusions of the study of Lieutenant A's case as well as our future research areas.

/

Part 5 presents the appendices of this volume : the ***bibliography*** and a ***thematic index***. The latter is followed by the ***end notes*** of the research.

/

An **ANNEX** CD is available that presents the detailed data gained or elaborated throughout the study of Lieutenant A's case. The **EP data set, PM data set, and CogOp data set** Excel files are also joined. Their definitions and analyses are provided in the annex volume (ANNEX 15). Copies of illustrations that may be difficult to read in the text are also provided on the CD.

TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

PREFACE

Acknowledgements

First, I really want to thank my dear Marie-Anne who coped with my thesis these past seven years. Her joyful character was an invaluable support, especially in the worst moments of doubt.

I dedicate this piece of work to my parents. My late father, I know, was so proud, and amused, of my undertakings and permanent enthusiasm. His disease killed him and he will not see the end of this, but at the moment of presenting my thesis I have an emotional thought for him. My gratitude goes to them both for they communicated to me an unstoppable will to act on my goals and have provided me with a background without which I would not have got where I stand today. I hope I passed this will on to my own children.

On the academic side, my gratitude goes to my supervisor, Chris Johnson, who accepted an old PhD student like myself and introduced me to Naturalistic Decision Making studies and the ethics and duties of scientific research. I owe him to have thrust so much effort into my methodology and to have spent many agitated nights reflecting on Occam's razor.

I would like to thank Firemen at the Brigade des Sapeurs-Pompiers de Paris (BSPP), especially Lieutenant A, and those who made this study possible at the BSPP headquarters and at the G1 Headquarters and 9th Rescue Company of Montmartre. I wish to thank for their help Pierre Vermersch and the late Georges-Yves Kervern who introduced me to the BSPP. I wish this research be one day useful to the BSPP, to Firemen in general, and to all people engaged in dangerous activities who may suffer Critical Incidents in the course of their work.

Author's Declaration

This dissertation is submitted in accordance with the regulations for the degree of Doctor of Philosophy of the University of Glasgow. No part of it has been previously submitted by the author for a degree at any other university and all results contained within it are claimed as original.

DEFINITIONS & ABBREVIATIONS

AM : Autobiographical Memory

BSPP : Brigade des Sapeurs-Pompiers de Paris (Paris Fire Brigade)

CI : Critical Incident

COA : Course of Action

COE : Course of Events

CogAct : Cognitive Act

CogObj : Cognitive Object

CogOp : Cognitive Operation = a {CogAct ; CogObj} pair

DM : Decision Making

DM Step : Decision-Making Step

DMA : Decision-Making-in-Action

EI : Elicitation Interview

EM : Episodic Memory

FBU : Fire Brigades Union

IAFC : International Association of Fire Chiefs

JDM : Judgement and Decision Making

LTM : Long-Term Memory

NDM : Naturalistic Decision Making

PCA : Pheno-Cognitive Analysis

PM : Present Moment

PTR : Peritraumatic Resilience

RPD : Recognition-Primed Decision

RPDM : Recognition-Primed Decision Model

STM : Short-Term Memory

TRAUMA : unless otherwise specified, “trauma” designates psychological, not physical trauma

WOA : World Of Activity

Part 1. THE PROBLEM SPACE

CHAPTER 1. Fire-fighters under attack : Lieutenant A and the rottweilers

The work reported in this study is based on a field research carried out between the beginning of September and the end of December 2007 as part of a larger project run by the Paris Fire Brigade (Brigade des Sapeurs-Pompiers de Paris - BSPP) aiming at better understanding how Fire-fighters cope with the difficulties of their work. While 75% of BSPP's interventions are victim rescue missions (non-fire fighting), attacks against firemen have multiplied and impact on their personal and professional life. Aggressions can be perpetrated both by humans and by dangerous dogs. This chapter seeks to shade light on this phenomenon. We establish that such incidents are regular and that they are considered as Critical Incidents (CI). We show that their occurrence has generated post-traumatic support to tackle the risk of Post-Traumatic Stress Disorder (PTSD) but that no consideration seems to have been given yet to the peritraumatic stage (during the intervention itself) of this phenomenon. We conclude by affirming that where statistics are needed to shade light on this problem, these cannot account for the individual, subjective experience.

1.1. Firefighting as a high-risk profession

All fire-fighters have had or will have to handle Critical Incidents in the course of their missions (Keenan, 2008 ; Regehr et al., 2005). In the USA, the International Association of Fire Chiefs[3] (IAFC, 2013) indicates that "*Although the trend over the past 10 years has been a gradual but steady decrease in firefighter fatalities, 2013 has seen numerous multiple-firefighter fatalities*.". The IAFC, founded in 1873 as the National Association of Fire Engineers (NAFE), publishes hundreds of reports on their Near-Miss Reporting System's web page[4] and on their web site[5].

For instance :

Report Number	Report	Report Date	Event Date
13-0000301	Crew trapped by flashover.	02/14/2013 2032	02/11/2013 1423
12-0000279	Open valve causes line to whip.	12/10/2012 0723	11/16/2012 0000
12-0000266	Training assist FF in gaining control of skidding pumper.	11/15/2012 1450	08/31/2009 0000
12-0000246	Medical oxygen bottle explodes during fire.	09/06/2012 1652	09/01/2012 1412

12-0000238	Engine drives away with LDH still connected.	08/28/2012 1438	06/28/2012 1115
12-0000237	Firefighter falls from moving apparatus.	08/23/2012 1617	08/16/2012 2300
12-0000230	Depeleted red blood cells cause FF to fatigue.	08/09/2012 1518	08/07/2012 1830
12-0000227	Adverse heat drives interior crew out.	08/07/2012 1948	07/14/2012 1850
12-0000226	Attack crew initiates entry with no water.	08/07/2012 1737	10/28/2008 0030
12-0000215	Crew member falls through floor.	07/17/2012 1547	07/16/2012 2230
12-0000210	RIT evaluates roof collapse indicators.	07/11/2012 0017	05/30/2012 2100
12-0000183	Lack of water impacts firefighting efforts.	06/26/2012 0959	12/07/2009 2200
12-0000177	Dirty lens nearly causes FF to fall.	06/20/2012 2146	12/24/2007 0000
12-0000166	LDH damaged when crossed by apparatus.	06/15/2012 2100	05/28/2012 1600
12-0000155	No water in the tank to fight fire.	05/31/2012 2305	01/05/2012 0000

Table 1 Extract from IAFC's Near-Miss Incident Reports database

This problem is in fact universal. The first of Keenan's (2008) surveys of 98 Australian fire-fighters shows that "*all of the firefighters in [her] study had experienced a work-related traumatic event as part of their firefighting career, and the clear majority had experienced more than one such event*.", and even twenty or more in their career.

Regehr et al. (2005) report that "*56% of volunteer firefighters in New South Wales reported that their safety had been seriously threatened at some time, 26% in the last year (Marmar et al., 1999). In addition to personal danger, firefighters are regularly exposed to the suffering and death of others. In a sample of 165 firefighters in Australia, 78% indicated that they had been exposed to at least one Critical Incident at work including the death of a colleague, injury on duty, mass casualties, or the death of a child (Regehr, Hill, & Glancy, 2000). Over 40% of 103 firefighters studied in Canada report being exposed to each of the following events: violence against others, multiple casualties, and the death of a child, and approximately 30% of firefighters report experiencing the death of a person in their care (Regehr & Bober, 2004). [...]*".

And it does not affect only fire-fighters but all emergency response forces. Marmar et al. (2006) add "*Police service is widely recognized as one of the most dangerous and stressful occupations. Police and other first responders are repeatedly exposed to potentially traumatic situations (also known as "Critical Incidents"), such as armed confrontations, motor vehicle crashes, and witnessing violent deaths*.".

Statistics have been missing and the number of injuries on the line of duty reported in the USA is underevaluated (Moore-Merrel et al., 2008) : "*Currently, there is a dearth of published information on firefighter injuries*." (p. 4)[6].

1.2. Attacks on fire crews

The same is true about the number of attacks perpetrated against fire-fighters in the UK says the Fire Brigades Union[7] (FBU, 2005)[8]. FBU (2008) mentions that "*official figures on the scale of attacks on fire service personnel for the UK as a whole are woefully inadequate*" (p. 45) and that "*The scale of attacks in Northern Ireland has only been made public when ministerial questions have been put on behalf of the Fire Brigades Union*" (ibid).

The number of attacks perpetrated against fire-fighters is high and has been rising steadily.

In the UK, "*The British Crime Survey (BCS) 2002/3, which is based on interviews with around 36,500 people, shows that fire and rescue fireghters and officers, along with police officers and prison service officers and other workers defined as being in 'protective service occupations', most at risk of experiencing violence at work. Fourteen percent of workers in this occupational category report that they experienced an incident of actual or threatened violence while working, in comparison with 1.7% of the workforce as a whole*." (FBU, 2005, p. 3). FBU (2008) indicates that "*Official figures obtained from every fire and rescue service in England and Wales suggest that overall attacks went up from 1,359 in 2005-06 to 1,506 in 2006-07*." (p. 45).

FBU (2005) provides several accounts of such events[9], and testimonies and statistics show that this problem is not confined to poor urban areas (FBU, 2005)[10].

The problem is the same in Scotland (FBU, 2005) and the Scottish Executive reported more than one such incident per day between April 2003 and March 2004[11].

In France, the number of attacks against fire-fighters has also seriously increased over the past years as Beignon (2003)[12] states. This trend is confirmed by the French crime observatory (*Observatoire de la Délinquance*)[13] who publishes statistics on attacks targeting Firemen provided by the Paris fire brigade, Brigade des Sapeurs-Pompiers de Paris (BSPP) . These show that the number of attacks against BSPP firemen increased drastically since 1993:

Year	Nb of attacks
1993	5
1994	4
1995	7
1996	0
1997	1
1998	2
1999	3
2000	10
2001	10
2002	18
2003	24
2004	59
2005	84
2006	93
2007	87

Table 2 Number of attacks against BSPP Firemen (1993-2007) ; Source: BSPP

If this figure remains modest in regard of the 430 000 interventions performed by the BSPP in 2007 as a whole, it has entailed several consequences, especially on G1's sector of intervention. Firemen's wives are not willing to live in suburbs where the feeling of insecurity has developed so much ; Firemen are recommended not to wear their uniforms on public transports ; and many of them are getting more and more depressed with the situation according to BSPP's Chief Psychologist leading to an 33% attrition ratio in 2006. In Scotland, FBU (2005) indicates that if serious incidents are rare, their cumulative effect has similar impacts on fire-fighters[14]. In the USA, Sweeney (2012) reports the variety of consequences CIs entail : "*the staggering number of heart attacks, suicides, unhealthy addictive behaviors, and high divorce rates in the fire service as well as the emergency medical service and law enforcement communities*.", among which the increasing attrition ratio in volunteer fire-fighters[15].

FBU (2005) explains that violence has now become part of fire-fighters' vision of their job, a reason along with heavy paperwork (FBU, 2008, 48) for under-reporting,

1.3. Attacks by dangerous dogs

Aggressions against emergency responders can also be perpetrated by animals during rescue operations in relation to victims attacked by dangerous dogs[16] like rottweilers and pit bulls, or during other operations such as suspect arrests by police forces. Reports of such victim rescue operations are manifold. In the UK, reports of attacks against dog owners can be found on the web[17]. FBU (2008, p. 39) mentions such an incident reported by the Grampian FRS. In the US, it is reported by DogsBite.org[18] that on February 17th, 2011 in Dillon, South-California, 66-years old Sirlinda Hayes was killed by her two rottweilers and emergency workers on arrival at the scene were threatened by the animals that were eventually shot by police deputies. On July 2nd, 2013 in Hawthorne, NBC

Southern California reports the attack of a rottweiler dog against Police Officers who were arresting his master. The dog had to be shot by them.

The general pattern of such victim rescue interventions is virtually always the same : emergency responders get to the field to assist victims, dangerous dogs threaten them, and if no other means of securing the place is available police officers shoot the dogs, thus creating a supplementary risk for other emergency workers.

1.4. Attacks against fire-fighters are Critical Incidents (CI)

Sweeney (2012) points to the fact that "*it is the men and women in the emergency service professions that are at a greater risk of suffering long-term stress that can lead to post traumatic stress disorder (PTSD). The 'rate for diagnosable PTSD among firefighters was 16.5 percent compared to a one percent to three percent rate for the general population—about one percent higher than PTSD rates of Vietnam veterans' (DeAngelis, 1995, p.36).*".

In the UK, FBU (2005) reports that "*Bill Feeley, Assistant Chief Fire Officer at Avon Fire and Rescue Service, said that one firefighter eventually left the service after a long period of sick leave due to post traumatic stress disorder. He had been involved in an incident in which a scaffold pole had been thrown through the window of a fire engine*." (p. 8). FBU's (2008) report on attacks against fire crews mentions that "*attacks on firefighters should be treated as trauma, with significant implications for stress, anxiety and depression*" (p. 44).

1.5. Lieutenant A and the rottweilers : the experience of a CI

Such is the case of Lieutenant A in 2007, in the northern suburbs of Paris. Lieutenant A is a young officer at the BSPP[19], with approximately five years of experience. The day of the events, he is the duty officer at his fire station.

When Lieutenant A hears the radio call at the Fire Station's main desk, he thinks that two people bitten by their dogs is not serious enough a reason to proceed to their home as something more important could happen then. But, when hearing that reinforcements are called in, he reconsiders his first opinion and his chauffeur drives him down to the victims' domicile.

Arriving there, a crowd has gathered around the main gate, eager to get glimpses of the events. His driver parks their car inside the premises, where Lieutenant A can see that the

two dogs are held in respect by armed policemen in the bottom-end of the garden, and he decides to attend to the victims, inside the house.

As one of the women is yelling, his attention is drawn to patches of blood and the scalped head of the youngest of the two, a daughter of twenty, her mother lying next to her, wounded only from knife cuts she had inflicted on herself when trying to kill her dogs who were attacking her beloved one. As the buzz in the villa's lounge indicates, they are well attended to by the medics and Lieutenant A goes back into the garden to see what is happening of the animals.

As he is standing in the midst of colleagues and Police Officers in front of the sited dogs, the father and husband of the women suddenly irrupts in the garden, shouting "*Kill my dogs ! Kill my dogs !*". Fearing the consequences of his violent behaviour, Lieutenant A asks him to stop but fails. Too upset, the man carries on shouting and advancing toward the dogs. Farther on his trajectory, a Police Officer also asks him to stop shouting and to calm down but is not more successful than the Lieutenant.

It is when the Police Officer pulled the father to the ground to stop him that the dogs got up on their legs and jumped forward... threatening everyone's security.

At that precise point in time, Lieutenant A' s attention is captured by the dogs' eyes, the universe around him becomes like a tube, and while Police Officers are shooting (forty-five) bullets to try to kill the rottweilers, that sounds to him like 14th July's[20] fireworks. As he then moves backward one or two steps, time is like suspended and he can see the bullets going through the dogs' bodies in slow motion and their impacts only affecting slightly their course.

Just after the dogs had run amidst the group, someone shouts "*one of them has escaped !*". Lieutenant A fears that running wounded on the streets she would be extremely dangerous. But after it was found out that all issues had remained closed, the search for the lost animal focuses on the garden and its many hidden corners, the cellar, and even the next door yard, the street-gate of which had also remained fortunately closed.

Ultimately her body is found next to the other dog's. Lieutenant A feeling reassured he talks to Police Officers and learns from them that forty-five bullets have been shot while he was standing right in the middle of their trajectories. Next, he goes back inside the house to

attend again to the women. Soon after, the latter are taken by two ambulance vehicles to hospitals, though not so easily as the crowd outside staring at them puts another load of psychological pressure on the Lieutenant and his men.

Some minutes later, a Television crew arrives to report on the event. Lieutenant A orders his men not to speak to them, as standard procedures request.

Once the victims have gone, realising that they had just escaped death, he and his driver talk in the car on their way back to the Station, the two men only thinking of what might have happened of them.

The story ends with the Lieutenant talking with colleagues from other Stations who were present on the premises the day of the incident and later on with his wife. And with an official report to write as it was an incident of an exceptional nature...

This critical incident is the central piece of the present research.

1.6. What is a Critical Incident ?

"*Critical incident stress is a normal reaction experienced by normal people following an event that is abnormal*" (NFPA, 1997). For Hammond & Brooks (2001), "*A critical incident is one that leads to an unusually powerful stress reaction that overwhelms the person's ability to adjust emotionally*.". For Mitchell et al. (2003) they are "*Extraordinary events that happen suddenly, without warning, and disrupt a person's feeling of control and faith in their surroundings*".

For Mitchell (1983), the theorist of CISD (Critical Incident Stress Debriefing), Critical Incidents are extreme events of a psychologically traumatic nature experienced individually. For Tuckey (2007) they are "*a potentially traumatic event*". They are also described as traumatic by Marmar et al. (2006) as they trigger "*terror at the time of the threat*". Marmar et al. (2006) give examples of CIs : "*Police and other first responders are repeatedly exposed to potentially traumatic situations (also known as "Critical Incidents"), such as armed confrontations, motor vehicle crashes, and witnessing violent deaths*.". And Bertrand (2007) characterises Critical Incidents by referring to extreme situations[21] that are1) violent and intense, 2) sudden and unexpected, 3) impossible for the subject to handle by resorting on his usual routines and resources. Weick (1993) calls them

"*cosmology episodes*" in his famous re-reading of the Mann Gulch disaster[22], and characterises them as the experience of the collapse of sense for the subject.

This characterisation of CIs as traumatic in nature is moderated by some researchers however. For instance Duchet (2007, p. 124) says Critical Incidents are only "*disturbing the return to the field of his teams of professionals*"[23] while trauma is "*an event of a larger scale*".

Life threatening, intense, sudden, inconceivable, beyond ordinary handling procedures, Critical Incidents overall seem to be of a traumatic nature, and the nature of the traumatic experience has to be explained. But how do fire and rescue services help their staff to cope with CIs ?

1.7. In conclusion : The need to study the experience of attacks against firefighters

FBU (2008) reports that only "*A small number of fire and rescue services have conducted or supported research into attacks against firefighters*." (p. 49). The usual support provided in response to such occurrences is Critical Incident Stress Management (CISM).

For Mitchell et al. (2003), *"The main goals of a debriefing are to mitigate the impact of the traumatic event on victims and to accelerate recovery processes. It is intended for use with emotionally healthy people who are experiencing acute, normal stress reactions to abnormal traumatic events. It helps the participants to: (1) verbalize their distress; (2) form appropriate concepts about stress reactions before false interpretations of the experience are formed; and (3) return to routine functioning*." (p. 46). Hammond & Brooks (2001) indicate that "*CISD is now part of a comprehensive spectrum of techniques called critical incident stress management (CISM), and may be supplemented by earlier interventions, such as demobilization or defusing, or one-on-one encounters. CISD is neither psychotherapy nor counseling, but is instead designed to promote emotional health through verbal expression, cathartic ventilation, normalization of reactions, health education, and preparation for possible future reactions.*".

Sweeney (2012) reports that "*Firefighters receive little if any training or support to help them cope emotionally with traumatic stress. Following a distressing (the death of a child, a mass fatality, or the death of a fellow firefighter in the line of duty) some fire departments may implement a critical incident stress debriefing (CISD) or offer the*

assistance of department chaplain. However, only a small number of departments offer educational programs on coping with traumatic stress and grief for the firefighters, their families, and department chaplains."[24].

The attention of emergency services focuses mainly on Post-Traumatic Stress Disorder (PTSD) and the mitigation of the psychological impacts of CIs.

Conversely, it seems that how an individual fire-fighter copes with a critical incident that affects him *during* an intervention has received insufficient attention yet.

Reports of such experiences can be found for instance on the IAFC's web site. Produced in an institutional context, and apart from a narration and interesting lessons learnt in terms of needs for improving situation awareness, collaboration, equipment, training, standard operating procedures, etc., they contain no study of fire-fighters' decision-making in action. This is the case for instance with report number 10-0001072 of 08/30/2010 provided by IAFC (2013a) about a fire-fighter falling through a collapsing floor right into the middle of the blaze consuming a family home's basement. IAFC (2013a) also publishes report number 05-0000267 of 05/27/2005 about a fire-fighter who intervenes with medics to rescue a woman said to have attempted suicide. The victim pulls a knife out of her pyjamas and threatens to cut the throat of an emergency worker. Testimonies provided by the New-York Fire Department's Officers and Men after the 9/11 events[25] show to what lengths these people went to save their and others' lives.

The experience of a CI still needs to be studied and as CIs are deemed to be traumatic, the next chapter presents trauma and its essential features.

CHAPTER 2. Trauma and the peritraumatic experience

Critical Incidents (CI) are of a traumatic nature. This chapter therefore presents the different aspects of the concept of trauma. We focus our attention on the peritraumatic phase, for McNally (2003) and Gershuny & Thayer (1999) the word *peritraumatic* referring to *the time of the exposure to a traumatic event*. We clarify the difference between stress and trauma. We present one of the essential features of the experience of trauma, peritraumatic dissociation. Finally, we characterise the potential reactions to trauma exposure and discuss the potential impact of CIs on fire-fighters' capacity to make decisions and to complete their duty at the peritraumatic stage.

2.1. What is trauma ?

2.1.1. Trauma, its characteristics, its different types

If trauma is an old notion (Dayan & Olliac, 2010)[26], for Sauzier (1997)[27] "*the definition of trauma itself is still broad, vague, and changeable*", and Gershuny & Thayer (1999)[28] show that in the American psychiatric tradition, the concept of trauma evolved from the vague notion of an extraordinary event to the more specific notion of a life-threatening event, the life at stake being that of the subject himself or of someone in his immediate vicinity.

The word "trauma" as used by Freud[29] conveys three meanings say Laplanche & Pontalis (2004, p. 500) : "*that of a violent shock, that of an intrusion, that of consequences over the whole* [psychological] *organisation*", and they further explain[30] that trauma is by nature overwhelming one's capacity to cope because "*the incoming flux of excitation overwhelms the psychic apparatus' tolerance […] leading to a failure of the principle of constancy*"[31].

Trauma is not the ordinary surprise[32] encountered in everyday life, but the surprise of meeting an *unbearable-beyond-imagination detail* that surpasses in horror anything that the subject had tried to anticipate. It is, says Crocq (2007a)[33], a violent event that "*puts us in touch, suddenly and directly, with the reality of death*", and for Vrignaud (2008, p. 146) it is "*a frontal shock with the (un)human face of reality*". For Lebigot (2005, pp. 28-29)[34], trauma is a long lasting "*effraction*", an "intrusion" into one's psyche resulting from a "fright" ("*effroi*" in French), from terror[35], the subject being *untimely confronted with the reality of death*, an unbearable shock due to the "*sudden encounter with a detail that takes the subject beyond what he had ever thought horror could be*"[36] (ibid, p 19).

Gershuny & Thayer (1999) stress the current consensual characterisation of trauma: it entails an exceptional level of affective excitation : "*intense fear, helplessness, or horror*", and the experience of trauma is "*subjective*" and depends on one's familiarity with circumstances.

2.1.2. Different traumatic circumstances

Trauma can be experienced in a variety of circumstances. Lebigot (2005) indicates[37] that trauma refers to "*three different types of circumstances : for instance one's confrontation with one's likely imminent death, or with the unbearable and unimaginable pain inflicted on someone else, or it has to do with people's involvement in others' death (for instance through torturing them), even if in that case they are prepared for the other's death*"(p. 15). He adds it can also be associated with one's sudden feeling of complete abandonment by the surrounding world as in the case of a rape or the complete collapse of one's system of beliefs and values. Vrignaud (2008) reports the case of Mrs N who suffered violence and rape in jail after being arrested for political activism in her country. Vrignaud says Mrs N "*confronted the destruction of what founded her as desiring and speaking human being […] links were broken, the laws of nature were attacked, the symbolic order upset, taboos broken*" (p. 145). Laplanche & Pontalis (2004, p. 500) also assert that trauma may lie not only with a "*very violent event alone*" but also with "*an accumulation of excitations each of which would be tolerable*".

2.1.3. Trauma or traumatism ? The choice of a working definition

As we can see from these definitions, the difference between *trauma* and *traumatism* is unclear. Laplanche & Pontalis (2004, p. 499) explain that "*trauma*" designates "*a wound with an intrusion*"[38] whereas "*traumatism*" rather designates "*the consequences on the whole organism of a lesion resulting from external violence*", though, they say, Freud himself tended to use one word for the other. Rousseau-Dujardin (1998) gives an opposite definition. In this thesis we shall consider that *trauma* is equivalent to a stressor, while *traumatism* is the process by which trauma affects the subject and its consequences, and *trauma exposure* is the encounter with trauma.

2.1.4. Trauma vs. stress : the choice of an unambiguous definition for the thesis

Despite such neat characteristics, the difference between stress and trauma often remains unclear. For instance in Kowalski (1995) talks of *traumatic stress*[39]. And in their study of the response of emergency workers to Critical Incidents that happened during the 1989

Loma Prieta earthquake Interstate 880 freeway collapse, stress is referred to as "*routine non-CI stress*" by Marmar et al (2006), differentiating stress from Critical Incidents (CI) but creating confusion between CIs and trauma that appears as *CI-stress*.

2.1.4.1. Stress as a staged and variable process

Quoting Welford (1973)[40], Schönpflug (1983, p. 299) defines stress as "*arising when motivating conditions are not reduced by the organism's actions (Welford, 1973, p.568).*", and Cox et al. (2000) define it in terms of a negative balance between cognitive demand and cognitive capacities : "*stress can be said to be experienced when the demands from the work environment exceed the employees ability to cope with (or control) them.*".

Lazarus (1993b)[41] showed the tight inter-relation of stress and emotions and extended the definition of the former to suggest a staged model of coping and to define stress itself as a staged reaction to a stressor[42]. Carver et al. (1989) explain that for Lazarus, appraisal and coping form one single process made of three steps (primary appraisal, secondary appraisal, and coping)[43] that may loop into one another if circumstances require. Lazarus (1993b) also highlighted the "*transactional*" nature[44] of emotions, the reaction to a stressor depending on two cognitive processes[45], namely "*appraisal*"[46] and "*coping*", shaped by both endogenous and exogenous factors[47]. The concept of "*appraisal*" was formed around the notions of *relational meaning* and *noxiousness* and it was placed at the centre of his definition of stress[48].

The "*relational meaning*" of an event is what the stressor means to the individual in terms of "*valence*", the quality and level of affection of his well-being (its potential *noxiousness*), and it results from the appraisal process (Lazarus 1993b)[49].

In Lazarus (1993b), *valence* is nil if there is no stress, positive if the appraisal is positive - Selye (1974)[50], quoted by Lazarus (1993b), coined "*eustress*", "*the good kind of stress because it [is] associated, presumably, with positive feelings and healthy bodily states*" -. Where there is eustress there are positive emotions. A negative valence generates distress, "*the bad kind, associated with negative feelings and disturbed bodily states*" (Selye 1974) i.e. negative emotions. The *nature of the threat* is presented by Lazarus (1993b) in terms of a *congruence vs. discrepancy* between an expectation or belief on one hand and an actuality on the other hand. Its appraisal may be dependent also on other variables, namely *personality* and *intentions*[51]. Finally, the *individual's capacity to change the course of events* is also determinant (Lazarus 1993b)[52].

The coping process, Lazarus (1993b) says, involves a mix of cognition and action[53], and it varies with circumstances (Lazarus 1993b)[54]. It is also influenced by individuals' own "*coping style*"[55] (Lazarus 1993b)[56]. And like Schönpflug (1983), Lazarus (1993b) suggests that there are two fundamental "*coping strategies*"[57] (also see Carver et al. (1989), building on Lazarus & Folkman (1984)), one that aims at reducing the stressor, the other aiming at enhancing the way the stress reaction is handled. Coping strategies tend to match circumstances at hand[58] (Lazarus, 1993b), and if circumstances vary "*Coping strategies change from one stage of a complex stressful encounter to another. If we lump together the stages in a complex encounter we gain a false picture of the coping process*." (ibid). For Carver et al. (1989) coping strategies are selected by subjects on the basis of their appraisal of the changeability of the situation[59], but only to underline that "*the distinction between problem-focused and emotion-focused coping […] has proven, however, too simple*" (ibid), and to evidence a set of more refined "*tactics*" and "*ways of coping*"[60] (ibid), the cognitive selection of which may depend on numerous factors[61].

2.1.4.2. A high-level model of coping with stress and safety concerns

When people are involved in stressful activities their safety and their ability not to compromise the execution of their mission are the main concerns. A *controlled* rather than an *uncontrolled* reaction is expected from them as Lazarus (1993b) and Hockey (1983) remind that stress may affect our functioning, and emotions, fear or anxiety for instance, may lead to different degrees of failure in action (Idzikowski & Baddeley, 1983)[62].

A *high-level model of coping* can be elaborated from what precedes, describing a *stressor → appraisal → arousal (emotion / stress) → coping → response [reaction]* process :

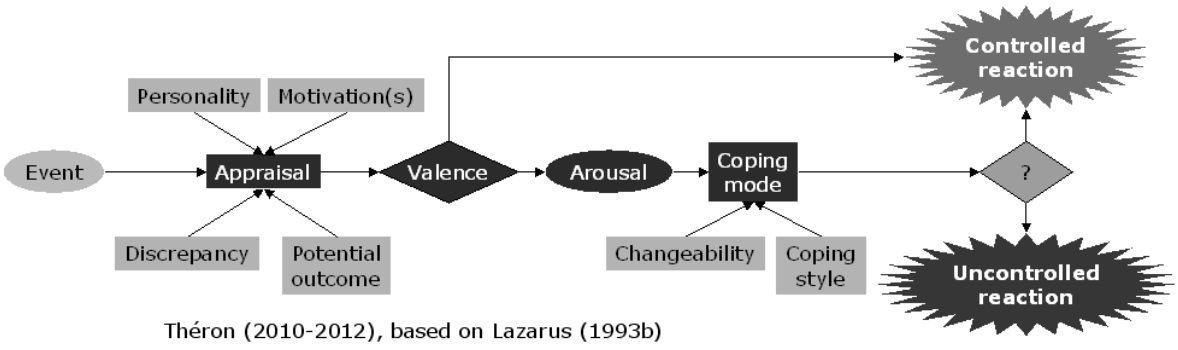


Figure 1 A high-level model of coping : stressor → appraisal → arousal → coping → response

Such a model suggests that the elements of the process it depicts could be levers usable to reduce stress. For instance, as Coates (1997) explains[63], providing clear goals may reduce

stress, a view shared by Annett (1997). In this context, *priming* would be an important factor of coping as noted by Colman (2006)[64].

2.1.5. Our working distinction between trauma and stress

A neat difference between the two concepts appears now. In this thesis we adopt the following working distinction.

Trauma (or traumatism) refers to a long lasting *psychological effraction*, without gradation[65], due to a violent, most unexpected shock that puts the subject in touch with death or with the collapse of his beliefs or values, and that overwhelms his adaptive capabilities.

Stress only refers to a *temporary pressure* on the individual's psyche, caused by situations mostly anticipated or expectable and that disappears once the individual has ceased to be exposed to the stressor. For Lebigot (2005) stress is some light suffering generating anxiety that the subject can handle, and for Schönpflug (1983) a kind of linear, progressive, scalable, equation of demand (difficulty) and capability.

2.1.6. The clinique of the peritraumatic experience of trauma

Clinical observation has helped psychologists and psychiatrists to understand further the concept of trauma and the symptoms of the time of the exposure. This is particularly interesting as the underlying cognitive process of the peritraumatic experience is ill-known (van der Kolk, 1997 ; Anaut, 2006).

2.1.6.1. Three aspects of the peritraumatic experience

Clervoy (2007, p. 35) explains that traumatic events affect individuals at the time of their exposure in three manners :

- Unpreparedness : The individual being made overconfident by his professional milieu is made weaker in the face of extreme situations as he is less prepared to handle them, which increases the intensity of the surprise[66].

- Surprise, senselessness and disorientation : The second fold of the process according to Clervoy (2007, p. 42) is that, being exposed to the unimaginable while so confident, the

individual is disoriented, left alone, without words to form a mental picture of what is going on. His routines are made useless by a totally new situation, taking him aback[67].

- Peritraumatic dissociation : Third, Clervoy (2007) says, the individual is tantalised, paralysed, left in a state of mental dereliction or isolation[68]. He experiences psychological "*peritraumatic dissociation*", a central feature of psychological traumatism (Gershuny & Thayer, 1999 ; Kennedy et al., 2004).

2.1.6.2. Peritraumatic dissociation as fragmentation of the psyche

According to Kedia (2009), peritraumatic dissociation can be defined as the collapse of the psychic unity[69], "*spacing out*" in Pynoos et al.'s (1997) terms. The word, Kedia says (ibid) is used for the first time in 1845 and will be reused by Janet (1889) in his work on hysteria[70]. Janet's dissociation theory (Colman, 2006) supposes an "*automatic subconscious activity, spontaneous and regular*" (Kedia, 2009) under the level of consciousness. For Janet (Kedia, 2009) "*the mind synthesises the activities of the conscious and subconscious levels, allowing for the unity of the Self and organising the subject's present activity*"[71]. Kennedy et al. (2004) support this view : "*Dissociation can be defined broadly as a failure to integrate experiences (memories, perceptions, etc.) that are normally associated (e.g., Janet, 1889).*".

Dissociation deteriorates the mind's capacity to operate this psychological synthesis, and creates a psychological split[72] through which thoughts, emotions and behaviours can function independently of each other. This is why in this state of psychological fragmentation (Clervoy, 2007, pp. 276-277) the subject is unable to react, only to be the spectator of the course of events that seems to progress in slow motion, as if time and space were suspended[73], he is unable to think, everything becomes suspended, idled, his thoughts, time[74].

2.1.6.3. The symptoms of peritraumatic dissociation

If Gershuny & Thayer (1999)[75] indicate that there is no consensus on several of the symptoms of peritraumatic dissociation clinical observations note that these can be :

- Derealisation (McNally, 2003 ; Gershuny & Thayer, 1999 ; Kennedy et al., 2004 ; Kindt & van den Hout, 2003 ; et al., 2004): the "*experience or perception of the world as unreal, strange or alien*" (Colman, 2006, p. 203).

- Depersonalisation (McNally, 2003 ; Gershuny & Thayer, 1999 ; Kedia, 2009 ; Kennedy et al., 2004 ; Kindt & van den Hout, 2003 ; McLeod et al., 2004): the sense of being a spectator to one's own fate (Colman, 2006), also called "*Out of Body Experience*" by Kindt & van den Hout (2003).

- Time distortion, or altered time perception (McNally, 2003 ; Kindt & van den Hout, 2003): a sense of time slowing down or speeding up.

- Emotional numbing (McNally, 2003): a loss of the sense of affect, of emotions.

- Dissociative stupor (Colman, 2006 ; Clervoy, 2007): the "*profound diminution or absence of voluntary movement and responsiveness to external stimuli*" (Colman, 2006).

- Motor restlessness (McNally, 2003): a form of physical hyper-activity.

- Elevated heart rate (McNally, 2003).

- Analgesia (Kindt & van den Hout, 2003): the "*absence or diminution of pain sensation*" (Colman, 2006, p. 34).

If it has been said that psychological dissociation had a negative impact on one's capacity to synthesise the various elements of his experience, Kennedy et al. (2004) supported by Crocq (2007a)[76] assert that dissociation has also a protective function as its manifestations mentioned above "*serve the function of reducing awareness of intolerable information (both internally and externally derived)*".

2.1.6.4. The clinique of the peritraumatic reaction

Once the subject has undergone the three-fold process described earlier, it still remains for him to react in the real world and to cope with the experience for himself. This is what we shall call the "peritraumatic reaction" or "peritraumatic response", the subject's "*immediate reaction*".

Crocq (2007b) asserts that "*the clinique of the immediate reaction is ill-known*"[77] because psychiatrists and psychologists meet with victims only late after the exposure to traumatic

incidents, sometimes months or years later, when recurrent symptoms start making victims' lives a misery, when they suffer PTSD or ASD (Acute Stress Disorder)[78].

For Crocq (2007b) the peritraumatic, i.e. immediate (in-action) reaction to trauma exposure can be described along four folds (cognitive, affective, conative and behavioural) as either :

- *Adaptive* (Also named "*stress adapté*", "adapted stress", Crocq views it as a reaction of alarm and mobilisation (2007b, p. 17)[79]) ;

- *Maladaptive* (Also called "*stress dépassé*" ("over stress"), it may be caused by inner weaknesses in the subject's psyche or by exhaustion, or by his defencelessness / unpreparedness for a violent event, which may be also prolonged or repeated.[80]) ;

- Or *Pathological* (Pathological reactions may be either neurotic or psychotic. Both are thought to be based on prior mental pathologies[81]).

2.1.6.5. Autobiographical and episodic memory : the persistence of traumatic memories

Brewin (2003) and Kedia (2009)[82] affirm that dissociation would encode the memories of trauma into Sensory Accessible Memory (SAM), which would prevent their integration into the "ordinary" autobiographical memory, which would be essentially verbal (Verbal Accessible Memory, VAM), thus creating grounds for PTSD.

But all the experiences we live are usually memorised in Autobiographical Memory (AM). Autobiographical memory is (Conway, 2004, p. 562) "*our ability to recall knowledge of our past and to form detailed specific memories of single experiences.*", and therefore the ground on which our cognition operates in action[83] (ibid). AM is made of two distinct but complementary parts : episodic memory and autobiographical knowledge. Episodic Memories, Conway (2001, p. 54) says, "*represent knowledge of specific actions and action outcomes derived from moment-by-moment experience – the minutiae of memory.*"[84], while "*Autobiographical knowledge is distinct from sensory perceptual episodic memories which represent specific details derived from actual experience (Conway, 2001)*" Conway (2004, p. 563)[85]. Autobiographical knowledge stems from the consolidation of episodic memories (Conway 2001, p. 54)[86]. Conway (2001, pp. 56-57) distinguishes three levels of autobiographical knowledge : Lifetime periods[87], General events[88] and Mini-histories[89].

Autobiographical knowledge and episodic memories are closely tied together in recalls (Conway, 2004)[90].

Van der Kolk (1997) stresses the peculiar character of traumatic memories : their extreme persistence in autobiographical memory[91] : "*A century of studies of traumatic memories shows that they generally remain unaffected by other life experiences*" (ibid, p. 245). The retrospective study of the experience of trauma out of Autobiographical Memory is likely to be facilitated by the vividness and detail of its associated episodic memories.

2.1.7. How to find out if a subject was actually exposed to trauma ?

Retrospectively the researcher can evaluate if the subject has actually experienced trauma or only stress using Crocq, Cremniter and Coq's Immediate Stress Questionnaire (ISQ) presented in Crocq (2007b, p. 25). Its 20 questions are rated from 0 (absent symptom) to 5 (very intense) :

#	Question	0	1	2	3	4	5	Mark
1	I was not expecting this, I was surprised							
2	I was afraid to be hurt or ill-treated							
3	I was frightened for my life or one of my relatives' life							
4	My thoughts were fuzzy, slow or suspended (like a blackout)							
5	I didn't understand a thing about what happened							
6	I felt like I was living a nightmare							
7	I felt space-disoriented							
8	Time felt like accelerated or slowed down							
9	There are some aspects of the course of events that I cannot / couldn't remember							
10	I was horrified by what I was seeing							
11	I was feeling one or several discomforting physical symptoms like shaking, tight throat, tight chest, heartbeats, gastric of intestine spasms, being sick or a compulsive need to urinate							
12	I was insensitive (or feeling like I was floating)							
13	I was in a state of psychological disturbance or agitation							
14	I was feeling powerless							
15	My movements were slowed down (or I was even paralysed)							
16	I was gesticulating in a disorderly and uncontrolled manner							
17	I was acting mechanically, like an automaton							
18	I was screaming, I was stammering (or else I staid mute out of stupor)							
19	I felt abandoned							
20	For several hours after the events I felt very disturbed							
A total mark of 50 or over (out of 100) indicates that the subject experienced trauma		Total:						

Table 3 Crocq, Cremniter and Coq's Immediate Stress Questionnaire (ISQ)

Other questionnaires are also available to assess the reality of peritraumatic dissociation like the Peritraumatic Dissociation Experience Questionnaire (PDEQ).

2.2. Can trauma exposure impact on Firemen's ability to perform in the field ?

The process of the experience of a CI and the clinical description of peritraumatic reactions point to the risks posed by the subject's reactions[92]. But the question at the heart of this study stands on a less medical side : Can the extreme circumstances of a Critical Incident jeopardise Firemen's cognitive capabilities that control their action during an intervention and generate inadequate reactions ? Literature provides two opposite sets of answers to the question and the conclusion of the debate is most unclear at the moment.

2.2.1. The YES arguments and vulnerabilities in coping capabilities

Kowalski (1995) points to the fact that Critical Incidents may delay emergency personnel' reactions because of distress[93], the more so as the conditions of the exposure to trauma Mitchell et al. (2003) say in a study of Emergency Medical Personnel[94]. And for Marmar et al. (2006) fire-fighters' prior background and their appraisal of circumstances may both be determinant of the way they react in the face of trauma[95]. The experience of trauma is devastating for Clervoy (2007, p. 48)[96] and Kowalski (1995)[97] who says that the impact on the subject is emotional and inhibiting and that his coping mechanisms are overwhelmed[98]. Clervoy (2007) says that the subject looses initiative[99] for a while, in a state of expectation, of passiveness and powerlessness, in the contemplation of his own fate, his life being in the hands of destiny, the toy of which he feels he is, destiny that alone can decide upon his fate[100]. This devastating character of the traumatic experience is explained by individuals' vulnerability, a state of psychological unpreparedness for surprise (Bertrand, 2007)[101].

2.2.2. The NO arguments : peritraumatic resilience and the force of consciousness and will

But does the occurrence of trauma really necessarily imply that the subject's initiative is lost, or that his routines are made useless ? Real life examples contradict the previous view.

The testimony posted by a French Fireman on his blog[102], Fireman Cyril[103], a first-person account of a Critical Incident, does not show that the Fireman lost initiative, that his course of action was put to a halt, that his routines were of no use, lost. On the contrary, he seems to have found enough resources to keep acting despite the situation (which resources

though is not clear here as the material is raw and has not been elaborated through a controlled interview process). This particular case suggests that Fireman Cyril was moved by a superior motivation : to rescue the little boy, and by a total denial of the physical truth, the actual death of the carbonised child. At Mann Gulch, Dodge, Sallee and Rumsey resume action immediately after the fire whirl says Maclean (1993). Reports provided by IAFC (2013a) about fire-fighters experiencing CIs also show that they struggle to surmount adversity.

The concept of *defencelessness* or *helplessness* evoked by Gershuny & Thayer (1999) should be understood as the impossibility for the subject to reduce the violent threat. It can only be experienced passively. When Crocq (2007) evokes maladaptive or pathological reactions he refers to subjects with neurotic or psychotic backgrounds, which normally is not the case with fire-fighters whose recruitment seeks to select sound people, apt to face the dangers of the job.

2.3. Conclusion: The process of the experience of trauma

The experience of a CI is a staged process within the context of an action, for instance a fire-fighting intervention. Before the intervention, which we could see as a "*pre-traumatic stage*", is a preparation time during which fire-fighters may be trained to face trauma, and this stage extends until action starts.

For fire-fighters, the intervention starts when they are mobilised at the fire station or from a command post and they are dispatched to the field. The intervention itself, the "*peritraumatic stage*" of the Critical Incident, is the short time (40 to 60 minutes for victim rescue interventions, as said earlier) during which trauma is experienced. This spans from the start of the intervention until the subject terminates his mission, leaves the field and returns to the station.

After the intervention starts the "*post-traumatic stage*", the one during which PTSD symptoms are likely to appear, lasting from days and weeks up to the remain of one's life.

At the peritraumatic stage, the psychological shock encrusts into the subject's psyche unbearable memories of the event and generates peritraumatic dissociation and later the subject's coping mechanisms entail his reaction :

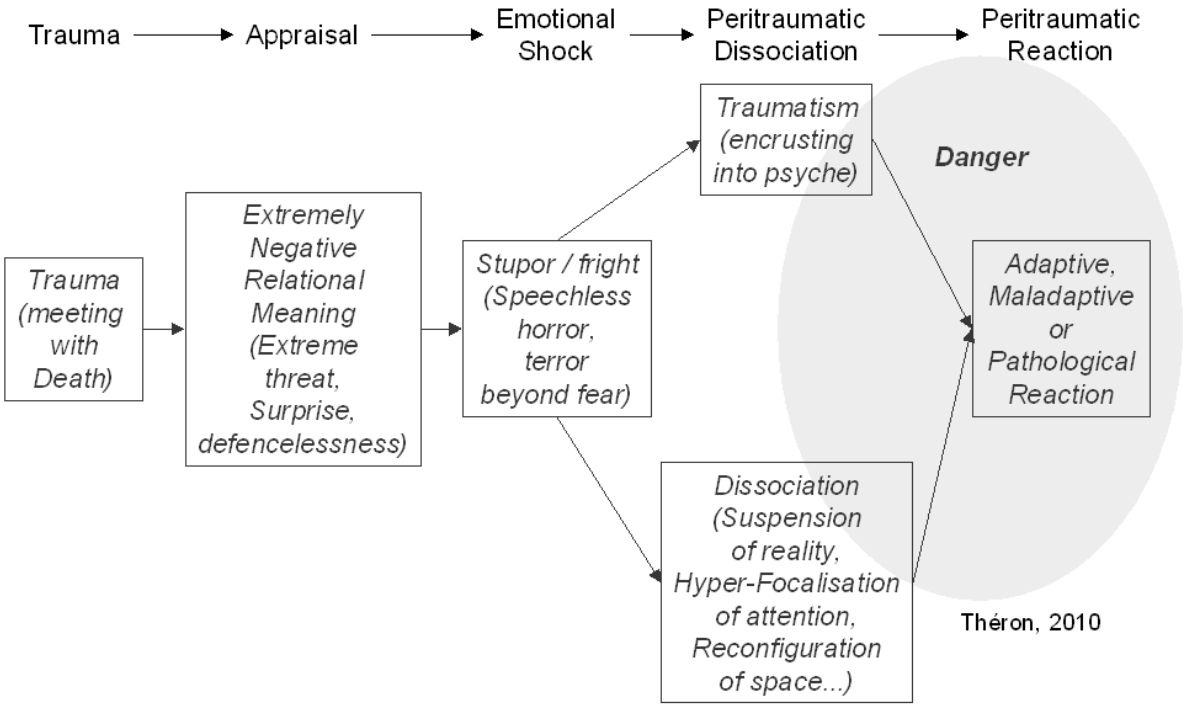


Figure 2 The general process of the peritraumatic stage of traumatism

The peritraumatic stage comprises the "exposure phase" described above, preceded by a "pre-exposure" phase during which conditions build-up to create the traumatic incident while the subject is acting on his duties, and is followed by a "post-exposure phase" when a fire-fighter is expected to resume and complete his mission.

The overall process of the traumatic experience could be summarised as follows :

Pre-intervention (hours to years)	Intervention : a given, delimited action (40 to 60' in BSPP victim rescue missions)			Post-intervention (years)
Pre-traumatic stage	Peritraumatic stage			Post-traumatic stage
	Pre-exposure phase	Exposure phase	Post-exposure phase	
Preparation for potential traumatic encounters	Situation build-up, with or without warning signs	Experience of trauma and traumatism	Action resumption	Possible PTSD syndrome

Table 4 The overall process of the traumatic experience

The peritraumatic stage is only one part of this whole process. It is delimited by the beginning and end of a given action performed by an individual in the field. Its duration can vary depending on people's activities. But in the context of BSPP victim rescue interventions, it would be a 40 to 60 minutes time slot.

As trauma and the peritraumatic stage have now been characterised, peritraumatic resilience has to be defined. One question could be, among others, at which of the phases of the peritraumatic stage resilience intervenes to make the subject surmount the traumatic

experience. One could understand that as early as the pre-exposure phase, when the subject is likely to perceive some warning signals, he could not act to get the situation under control. But would that be called peritraumatic resilience or incident prevention ? Is peritraumatic resilience intervening at the exposure phase, though theory points to the helplessness of the situation for the subject ? Or is it contained to the post-exposure phase when the subject is expected to resume acting on his duty ?

Now that we have a better understanding of the concept of trauma, of what the peritraumatic stage is and how it is itself decomposed into three successive phases, the next chapter’s endeavour is to elaborate a working definition of the notion of individual peritraumatic resilience (PTR).

CHAPTER 3. Peritraumatic Resilience and the research question

This chapter discusses psychological peritraumatic resilience. We do not consider here perspectives on resilience held in other domains like metal work, systems engineering, critical infrastructure protection, social-ecological systems, and so on. In this section we elaborate a working definition of *individual peritraumatic resilience* (PTR) that synthesises how the subject copes with a traumatic incident in the course of a given[104], delimited[105], situated[106], embodied[107] and enacted[108] action[109]. The study or PTR is concluded to be important for human safety in dangerous activities that requires the study of its underlying cognitive processes.

3.1. Perspectives on the concept of psychological resilience

3.1.1. A dominant focus on post-traumatic resilience

Resilience is a "*successful adaptation*" to adverse circumstances, says Lipshitz (1997, p.155). A search for "resilience" on the web sites of eminent psychological associations such as the British Psychological Society (BPS)[110] or the American Psychological Association (APA)[111] point to a dominant focus on post-traumatic resilience in literature.

APA (2013)[112] focuses on post-traumatic resilience, "*How do people deal with difficult events that change their lives? […] It means "bouncing back" from difficult experiences.*"[113]. A search for "peritraumatic resilience" or "peri-traumatic resilience" yields no result. A search for "post-traumatic resilience" yields 5 results, plus an additional 342 results in APA's "premium databases". And a search for "resilience" yields 39 results plus an additional 13264 results in APA's "premium databases", of which : 431 journal articles from PsycARTICLES, 109 book chapters from PsycBOOKS, 1688 grey literature from PsycEXTRA, 144 book and film reviews from PsycCRITIQUES, and 11838 abstracts from PsycINFO.

A search on the BPS' web site[114] for "peritraumatic resilience" or "peri-traumatic resilience" yields zero answer, while a search for "post-traumatic resilience" yields four answers : "*The struggle to leave military life behind*", "*Police: higher risk of psychiatric disorders*", "*War, earlier trauma and PTSD in troops*", and "*Our 2012 research grants announced*". And a search for "resilience" yields 55 news and articles, 20 events, 10 publications, 7 pages, and 4 press releases. Their topics all relate to post-traumatic resilience, either studies of factors of resilience or guidelines for resilience, etc.

The reason for the focus on post-traumatic resilience is of a public health order. Meredith et al. (2011) support this view. Their RAND report "Promoting Psychological Resilience in the U.S. Military" seeks to contribute "*to promote health and prevent negative consequences of war on the nation's service members and their families*." (p. iii) as "*The long and frequent deployments of U.S. armed forces associated with Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF), combined with the other consequences of combat, such as exposure to trauma, have tested the resilience and coping skills of U.S. military service members and their families*." (p. xiii). Psychology and Psychiatry seek to find ways to help patients to resolve the long-term effects of trauma exposure, PTSD, the Post-Traumatic Stress Disorder[115], say Matthews & Chu (1997). And when psychiatry gets interested in the peritraumatic experience, it is (Pynoos et al., 1997) to study its predictive character of a later PTSD syndrome and of its severity.

3.1.2. A review of perspectives on resilience and their practical consequences

The term Resilience became popular when it entered the field of Social Sciences, especially in Developmental Psychology, Psychiatry and Healthcare. It is a composite object which can be studied, with nuances, from different angles :

- Its object : individuals, groups, organisations, social-ecological systems, …
- Its context : Emergency Work, the Military, Mental Health and Child Development, the workplace, leisure, …
- Its nature : an ability, an outcome, a process, …
- Its reference : is it a response to stress or trauma, repeated exposure or one-shot events, …
- Its factors : what makes a resilient individual (for instance) resilient ? Genes, education, experience, …
- Its process : how does one achieve resilience ? Out of creativity, in a mediation between self and world…
- Its time span : from before the exposure stage to well after the exposure.

- Its impacts : how does it help people ? To come safe out of immediate danger ? To keep going ? …

- The methods of its study : from sociology to psychiatry and genetics through phenomenology.

Meredith et al. (2011) found 270 "*relevant publications*" on factors of resilience and report that "*many definitions share some common attributes, including strength to endure some type of traumatic stress or adverse circumstances. Some definitions focus on adaptive coping that results in coming back to baseline functioning levels, while others emphasize positive growth (Connor, 2006; Punamaki et al., 2006; Tedeschi and Calhoun, 2003; and Tedeschi and Calhoun, 2004) or thriving and flourishing (Fredrickson et al., 2003) beyond baseline functioning*." (p. 2).

Different, if not conflicting views are held within the research community on resilience.

Everall et al. (2006) and Metzl (2007) summarise[116] three different perspectives on the nature of resilience, commonly found in literature. They show that resilience is a multi-facetted concept : *"(1) a stable personality trait or ability […] ; (2) a positive outcome […] ; or (3) a dynamic process*".

Rutter (1998) and Titus (2002) summarise the views held on the nature of resilience under a Mental Health perspective[117] : an individual characteristic, and individual's interaction with the environment, a balance of good and bad experiences, a type of immunisation, or else something useful and even necessary for human development.

Such differences have practical implications in fact. For instance, as there is an opposition between the trait approach and the process approach, "*Masten (1994) has recommended that the term resilience be reserved to describe the process of adjustment after experiencing significant adversity. This recommendation is based on the concern that labeling an individual as having or lacking the personality trait of resilience carries the risk that some people will feel that they have inadequate resources for coping. Thus, based on this literature, we consider competence despite adversity as resilience, whereas resiliency is considered a trait. We focus our study on the process of resilience*." (Meredith et al., 2011, p. 3). Such a distinction has a practical utility : Meredith et al. (2011) say that they "*consider resilience to be a process, because if it were a trait, it would not be*

malleable; therefore, training to improve resilience would be futile." (p. 3). This view rejoins the view held by APA (2013) and BSP (2013) that people can train to improve their resilience : " *It involves behaviors, thoughts and actions that can be learned and developed in anyone.*" (APA, 2013).

3.2. Resilience is the outcome of a cognitive process

Cyrulnik (2006) asserts that resilience is always an interactive construction, "*a transaction between what one is and what is [in the world]"*. Pynoos et al. (1997, p. 275) say that they "*have consistently found that the experience of a child during a traumatic situation involves complex sensory, physiological, affective and cognitive processing of multiple moments with differing vantage points of concern*".

In Healthcare, Jacelon (1997)[118] describes the two phases of resilience, disruption and reorganisation. He says that the latter is driven by a need for *psychological homeostasis*. Damasio (1999) defines *homeostasis* as the process by which "*the organism, within defined limits, simply and quickly adjusts in an economical manner its functionning and energetic thrust in a constant search of an optimal state of balance*" (pp. 179-183). For Laplanche et Pontalis (2004) *homeostasis* is associated with the idea that the way an individual drives his life and keeps it within acceptable limits is controlled by unconscious psychological mechanisms such as the *Principle of Constancy* and the *Principle of Pleasure* (respectively *minimising excitations* and *intending to pleasurable actions*), or the *instinct of self-prese*rvati*on* (preservation of life).

3.3. Resilience is an aptitude stemming from four coping capabilities

Gerrard et al. (2004) assert that to be resilient one needs the ability to *cope*, "*defined as getting by, being adaptable, and withstanding future adversities*". The first two terms of this definition of *coping* are understood as dealing with the situation at hand and finding ways to work circumstances around at the peritraumatic stage, while the third one implies the idea of post-traumatic resilience.

Under a post-traumatic, child development perspective, Luthar et al. (2000)[119], supported by Edward (2005), define resilience as "*the achievement of positive adaptation despite major assaults on the developmental process*" in reference to a "*significant threat or severe adversity*". They associate it with three *abilities* : to persevere through difficult

times, to return to a state of mental and physical equilibrium, and to bounce back from adversity[120].

Anaut (2006, p. 86)[121] stresses the necessary correlation between resilience and traumatic events. Resilience is a response to traumatic events, not to ordinary, milder, stressors, which distinguishes it from coping with stress as defined by Lazarus and others. She (ibid) defines resilience[122] as an individual's capacity to rebound after coming out victoriously of traumatic situations, with further strengths, and as his capacity to keep control of his identity and to continue to project himself in the future in a way that conforms to this identity. In her words also, resilience is a process that spans beyond the time of the exposure to trauma, well into the post-traumatic stage.

Three factors of resilience can be identified in the definitions presented above :

- to *persevere* through difficult times, getting by, being adaptable

- to *resume* action

- to *bounce back* from adversity, to return to a state of internal equilibrium or a state of healthy being, to preserve identity and a sense of a future, and withstanding future adversities.

"*Persevering*" covers in fact two distinct and complementary notions particularly important at the peritraumatic stage, "*getting-by*" and "*resisting*", therefore leading to identifying four *coping capabilities* that allow an individual to be resilient :

- At the peritraumatic stage :

    - ***Getting by*** defined as "*continuing to perform despite activity*". This capability means that the subject manages to "do things", therefore to have cognitions, to make decisions and to act while facing traumatic circumstances.

    - ***Resisting*** the destructive pressures of circumstances, as long as needed. *Resistance* can be roughly defined as the more or less conscious mobilisation of various physical and psychological capabilities, such as robustness, hope, the management of one's margin of safety, situation awareness, etc., in order to avoid being

destroyed by adverse events. For instance at Mann Gulch (MacLean, 1993), to resist destruction Dodge first runs away from danger (i.e. he seeks to re-establish sufficient margins of safety between danger and himself). Then he orders his team mates to drop their heavy equipment to be able to run faster. Then, he lights up a fire escape and bends to the ground, which is a last resort choice aiming at trying to survive the imminent fire whirl. In this case, hope stands as an element of active resistance : hope to be robust enough to withstand circumstances, hope that the latter will spare oneself to a sufficient extent.

- "***Resuming action***": As one has already been "*getting by*" and "*resisting*", the sense of "*resuming*" is to return to a "*normal*", nominal level of performance, the one expected for instance from a Fireman who, after a Critical Incident, is supposed to resume and complete his rescuing activity. Resuming also means reconnecting with one's activity after it has been momentarily interrupted by trauma exposure.

- At the post-traumatic stage :

  - "***Bouncing back***" is a post-traumatic developmental issue as in Gerrard et al. (2004) : "*The essence of resiliency was captured in a comment by one of the participants: 'What doesn't kill you makes you stronger.' "*. Rebounding is the ability to recover a psychological and physical state as satisfactory as possible, to re-identify with one's identity or to elaborate a new identity, to project oneself into the future, to adjust to the new relationship one will have to his environment and the people around him or her, and to learn from the experience new strengths and skills to cope with potential future occurrences of Critical Incidents[123].

These elements allow to establish a working definition of peritraumatic resilience that will later allow us to link it to the study of the cognitive process of decision-making in action.

3.4. A working definition of peritraumatic resilience

In the thesis, we shall use the following working definition :

- Peritraumatic Resilience (PTR) is the capacity, the aptitude of a subject to cope with a traumatic incident in the course of a given, delimited, situated, embodied and enacted action.

Rebounding is not included in the definition of peritraumatic resilience as it belongs in the post-traumatic stage, and despite the fact it is a source of construction of new resilience capabilities.

3.5. In conclusion : the question and usefulness of this research

This research is driven by the following question : *How does a fire-fighter, Lieutenant A in this study, experiencing a Critical Incident in the course of an intervention, manage to resume and complete his action immediately after his exposure to trauma ?*

Anaut (2006) and van der Kolk (1997) report that the mental process by which peritraumatic resilience is produced is ill-known and should now be studied. A similar assertion was made in research on stress and emotions, for instance by Skinner & Zimmer-Gembeck (2007) who call for a "*microgenetic*" study[124] of the process of coping. This process involves a variety of cognitive functions. For Lazarus (1993)[125], coping strategies are complex and incorporate cognition, motivation and emotion. Departing from this view, Skinner & Zimmer-Gembeck (2007)[126] suggest that coping should be viewed as a set of ad hoc reactions setting in motion behaviour, emotion, attention, cognition, motivation and social relationships.

Literature shows that this process mobilises available helping *capabilities* such as the *instrumentation* of ad hoc artefacts[127] on hand (Engeström, 1999 ; Béguin & Rabardel, 2000) in order to find a way to achieve a circumstantial goal, for instance saving one's own life. For instance, at Mann Gulch (Maclean, 1993) this is what Dodge does when he creates an escape fire and it is also what Sallee and Rumsey, his team mates, do when they spot a crevice and use it as an in extremis protection from the fire whirl. Weick (1993) in his reanalysis of the same Mann Gulch disaster concludes that survivors displayed four capacities (while victims did not) : "*Bricolage*", "*Wisdom*", "*Respectful interaction*" and "*Preservation of a virtual role system*", bricolage equating precisely to instrumentation.

In IAFC's (2013a) case number 10-0001072, the firefighter who fell through a collapsing floor into the blazing basement of a burning house reports that once down there he "*began to try and find something to use to climb back up with.*".

Testimonies also show that the subject hangs on any possibility of rescue on hand and does not give up, though he is traversed by moments of hopelessness, of discouragement. For instance, in the same firefighter report he says :

> "*My deputy chief directed the crew to get the ladder into the hole for my escape. By this time, I was burned pretty well on my legs and struggling with exhaustion and the intense heat. I was screaming both from pain and due to fear. I could hear screaming coming from above, but was unable to make out the majority of it. I finally heard the word "ladder" and then felt something across my back. Once they got the ladder in to the basement, I had to get around to it. I still could not see anything but fire, so this was all by feel. As I started up the ladder, I got two rungs up, reached for the third rung, and lost my grip and fell back into the basement landing on my back. I was so exhausted that I started making my peace with God that this was where I was going to die. My wife and my three boys [names omitted] were at the foreground of my thoughts and I was thinking about never getting to see them again. Somehow, by the grace of God, I found the strength to get up again and start climbing the ladder once more. I got to the fourth rung and felt hands grabbing hold of me helping to pull me out.*".

This second extract of his testimony confirms that the subject exposed to critical circumstances that challenge his life processes them cognitively through a variety of cognitive operations and actions : perceptions, recalls, emotions, regrets, affirmative thoughts and instrumentation attempts, will, ceasing opportunities and persevering, … It also shows that at a certain moment other people help him and he ows them his rescue, showing thus the importance of the support of other crew members.

In the end of his testimony the subject draws lessons from his experience : he advocates training as a major way to prepare for potential critical incidents :

> "*Accidents happen, but you have to train hard and take the job seriously, whether you are a paid or volunteer firefighter, if you want to survive. Most of us go through our career in the fire service without injury, but it can happen at any time and at any fire. BE PREPARED! Take your training seriously. The more you train, the better prepared you will be. Nothing can really completely prepare you for this type of event, but the more you practice what to do, the*

more likely you are to react in the proper way. […] Had I had to wait on the RIT team for rescue, I would not be typing this today. Rely on your own skills and training to try and get out. Don't give up and just wait."

Routines and instrumentation skills, perseverance and will are what he says is required to surmount critical incidents.

In conclusion, peritraumatic resilience is assumed to be the outcome of an interactive cognitive process (Cyrulnik, 2006) mobilising a variety of cognitive functions. This cognitive process is complex and unpredictable[128], says Thompson (2007).

We posit that knowing better the cognitive experience of critical incidents, and thus how people manage to surmount them, can help firefighters as well as all people working in dangerous settings to enhance their safety in action.

The next chapter presents the current principles, general methodology and findings of the cognitive study of decision-making in natural settings.

CHAPTER 4. The cognitive study of Naturalistic Decision Making (NDM)

This chapter presents Naturalistic Decision-Making (NDM) research and contrasts it with Judgement and Decision Making (JDM) research. NDM has focused much on decision-making in computerised and collaborative environments and its cognitive models of decision-making are used to perform the cognitive engineering of systems, decision aids, or else training schemes, with a view to improve people's safety at work and to reduce human errors in stressful circumstances. We show that NDM research has considered decision-making as rational and has ignored the role affects play in decision-making. Meanwhile, JDM (Judgement and Decision Making) research has explored the role of affects but has taken account mainly of incidental affects, i.e. external and disturbing, non relevant to the task in progress. This chapter posits that the study of the role of affects into cognition requires idiographic[129] investigations of people's subjective experience and the production of first-person narratives. It concludes on the definition of Decision-Making-in-Action (DMA) as the individual cognitive process that controls one's performance in action, and as the fundamental object of the present research.

4.1. A brief, incomplete history of decision-making research

In the 40's and 50's Von Neumann & Morgenstern (1944), Rasmussen (1997) Edwards (1954)advocated prescriptive decision-making, what people should do to make rational decisions based on an expected utility function. Allais (1953), following Simon (1947), then showed that in reality people do not follow the principles of rational decision, which was to take Simon (1954, 1957, 1958) to develop his bounded rationality theory that states that people mainly make *satisficing* decisions. Because decision-makers don't have a clear vision of the problem to solve and have therefore to find a trade-off between possibilities, outcomes, and constraints. Simon's work placed the focus on the process of decision-making rather than on external ideal criteria and rules. The 50's and 60's saw the development of organisational decision-making studies with March & Simon (1958), Emerson (1962), Cyert & March (1963), or else Cohen et al. (1972). Those studies stressed the coexistence of different approaches to making decisions in organisations, not dictated by pure rationality but by interests, conflicts, circumstances and opportunities. By the end of the 60's, a certain sense of the binding of the decision-making process with a variety of factors emerged, whether internal factors like preferences and heuristics, or external like potential payoff, and contributed to put an end to the era of deterministic rational decision-

making theories (Festinger, 1964 ; Tversky, 1967 ; Tversky, 1969 ; Tversky, 1972 ; Tversky & Kahneman, 1974 ; Lichtenstein, Slovic & Zink, 1969 ; Lichtenstein & Slovic, 1971 ; Slovic & Lichtenstein, 1968). And around 1970, the relational psychology current of research postulated that a decision was a construction and not just the selection of a solution within a set of given possibilities (Watzlawick et al., 1967 ; Goffman, 1968 ; Bateson, 1972). Zadeh (1965 and 1978) introduced set theory and fuzzy logic. On November 15th, 1980, Charles Gettys and James Shanteau invited DM researchers to what appears to be the founding meeting of the Society for Judgement and Decision Making (SJDM)[130] and its afternoon programme announced "*Topics to be definitely discussed include "The Role of Rationality in Decision Making" and "Computers and Computer Aids in Decision Making.""*"[131]. March & Olsen (1986) saw decision-making as a rational process[132]. Hastie (2001) considered that people make decisions on the basis of underlying plausible story they construct to find consistency in the course of events. Lipshitz et al. (2001) define decisions "*broadly […] as committing oneself to a certain course of action*". Andrade & May (2004, p. 133) or Eysenck & Keane (2005, p. 481) referred to decision-making as choosing among various options. And Hollnagel (1998, 2000) had presented his COCOM Model (Cognitive Control Model) of action control, thus confirming that the study of decision-making has moved from a black-box to a white-box perspective.

By mid 80s, decision-making had become considered as a process, rationality becoming viewed as local (as the rationality of the decision-making process, or of a turning point in that process) rather than as a goal or an outcome (the "right" decision). This opened the door to naturalistic decision-making (NDM) studies.

4.2. A reinvention of DM Studies ? The emergence of NDM Research

From the beginning of the 90's onward, literature on Naturalistic Decision-Making flourished after the first NDM Conference was held in 1989 in Ohio to allow *researchers separating from main stream rational decision-making paradigm and methods* to share their views (Klein et al., 1993). Klein (1997) reports that "*many of the earliest NDM researchers ignored classic decision studies and had received no training in that framework"* (p. 20).

NDM studies did not focus on errors and biases[133]. As Klein (1997) explains : "*It is difficult for NDM researchers to identify and explain errors, and it is difficult to evaluate good decisions*" (pp. 17-18). The only function of the error concept "*is to trigger the*

investigation of the entire chain of causal factors" that lead individuals to committing them (Klein, 1997a, p. 389). Dekker (2002) adds that "*The new view of human error wants to understand why people made the assessments or decisions they made – why these assessments or decisions would have made sense from the view inside the situation.*" (p. 65).

The concept of expertise stood at the centre of NDM Research : "*experienced decision makers in many domains [appeared] to have little difficulty in choosing between options, their challenge [being] to appropriately categorize the situation*" (Klein, 1997, p. 13).

NDM therefore focused on "*the way people use their experience to make decisions in field settings*" (Zsambok, 1997, p. 4). Expert decision makers were studied "*as individuals or groups in dynamic, uncertain, and often fast-paced environments*" who "*identify and assess their situation, make decisions and take actions whose consequences are meaningful to them and to the larger organisation in which they operate*" (Klein, 1997, p. 5). And because expertise is built during a long period of activity, "*The study of decision making [could not restrict] to the moment of choice*" (Klein, 1997) but extend to the characteristics defining expertise.

When pressed by circumstances or risk at hand, Klein (1995), Klein (1998), Hutton & Klein (1999), to quote only a few, showed that, based on their superior capacities, experts often end-up considering only a single, feasible course of action in real settings, the first one that comes on their mind, the main concern being "*the way [they] represent the situation*" (Klein, 1997, p. 13), therefore placing emphasis on Situation Awareness.

NDM Research made some trade-offs and focused on the study of :

- The decision-making process in natural settings preferably to laboratories, to get ecological validity, research becoming more qualitative. But Pruitt et al. (1997) advocated the role of laboratory studies in NDM, hence a methodological trade-off and to "*go beyond CTA[134], however, and develop methods to ensure that 'naturalistic decisions' can be studied in more controlled settings. Laboratory work must have a place in NDM*" (p. 40), while Klein (1997) said : "*The interest in field settings does not preclude laboratory paradigms*" (p. 17).

- Experts, i.e. people who have accumulated experience so as to perform most tasks routinely, relying on more conscious processes only when circumstances become unfamiliar or more complex. But there may be limits to this focus as Pruitt et al. (1997) argue that "*one can learn a lot by studying those who are less-than-expert at a task, and that in the real world, many important decisions are made by those whose expertise is questionable. In fact, in many domains, true experts may not exist. It is the study of how a person uses experience and knowledge to tackle a problem which is of great interest to NDM*." (p.37).

- Situations simultaneously fast-paced, uncertain, dynamic and characterised by a certain level of adversity (Pruitt et al., 1997, pp. 34-35).

- The variety of DM Strategies applicable to different circumstances, like those exposed in Flin et al. (2007). Therefore, it would be wrong to equate NDM studies only with the RPD (Recognition-Primed Decision) Model, Klein (1997, p. 15) says.

Perhaps, one of the most important findings of NDM research is precisely this : the cognitive process of decision-making fits circumstances, its pattern is not set once and for all. Decision-makers adapt to situations. There is variability in the cognitive process of decision-making.

4.3. Firemen and expert decision makers

The study of Firemen's decision-making is at the origins of NDM. It has been studied mostly from the perspective of tactical decision-making performed in command posts by Commanding Officers (McLennan et al., 2006).

Firemen are "experts" in their field of play. Well trained, progressively dispatched to more and more dangerous and complex tasks, they develop strong routines and skills, and a knowledge of the "physics" of fire, among other things, that altogether give them the ability to make enlightened decisions (Hutton & Klein, 1999)[135]. Focusing on "Commanders", their description of expertise quotes prior research :

1) Dreyfus' (1972) and Dreyfus & Dreyfus' (1986) indicate that experts progressively move from an analytical understanding to an intuitive grasp of situations[136].

2) Rasmussen's (1983, 1986) Skill-Based Control is the expert level of decision-making though it is *not consciously goal-oriented* and "'*decision making' becomes an integrated part of task performance, and the expert may not even be aware that decisions are being made*.".

3) They precise the particular qualities experts show in making decisions. Experts have a "*vast domain-specific knowledge*". They "*perceive large meaningful patterns, or chunks of information, rather than individual pieces of information*". They "*are faster and make fewer errors*" as their "*skill being learned to automaticity*". Experts do "*not have to analyze a situation to perform well*". They "*have superior memory in their domain*" based on "*chunking*" and being "*attuned to the goal-relevant constraints in the environment*", which allows to "*[recall information] according to, or with respect to, those constraints*". They "*see and represent a problem at a deeper level*", "*at a causal level*" rather than "*at a more superficial level, based on surface features of a problem, and on learned rules*" as for novices. They "*spend more time trying to understand the problem*", "*in contrast to the novice who jumps right in and begins to manipulate the surface features of the problem*". Experts "*have refined perceptual abilities*", namely : "*the ability to see typicality, the ability to see distinctions, and the ability to see antecedents and consequences (through story building and mental simulation).*"

4) They lay the foundations of the Recognition-Primed Decision Model, positing that *in many real-world settings, people are performing their jobs with some degree of expertise*.

4.4. The RPD Model and the variability of the decision-making process

The Recognition-Primed Decision Model (Klein. 1989 ; Klein, Calderwood, & Clinton-Cirocco, 1986), conceived out of studies of fire-fighter commanding officers' decisions[137] (Lipshitz et al., 2001), shows "*the experiential basis of intuition*" (Klein, 1997, p. 15).

There are three basic versions of the RPD Model described by Hutton & Klein (1999) as well as by Klein (1997b, p. 286) and in other publications and conference acts by Klein and colleagues :

- "*Level 1 RPD, or the simple match, is a situation where the decision maker recognizes the situation as being one that has been experienced before, and the course of action to be taken is obvious. […]*"[138].

- "*However, in some circumstances, either the situation assessment or the appropriateness of the course of action are unclear. This leads to a more complex version of the model. In the case of an unclear situation assessment, where several hypotheses are possible, a further diagnosis of the situation may be required (Level 2). […]*".

- *Under certain circumstances, although the assessment may be clear, it may be necessary to evaluate a course of action before it is implemented (Level 3)*". This is "*performed serially, using mental simulation to test the adequacy of the option, to identify weaknesses of that option, and to find ways to overcome the weaknesses*" (Hutton & Klein, 1999).

To account for these various situations Klein (1998, p. 27) elaborated an integrated RPD model :

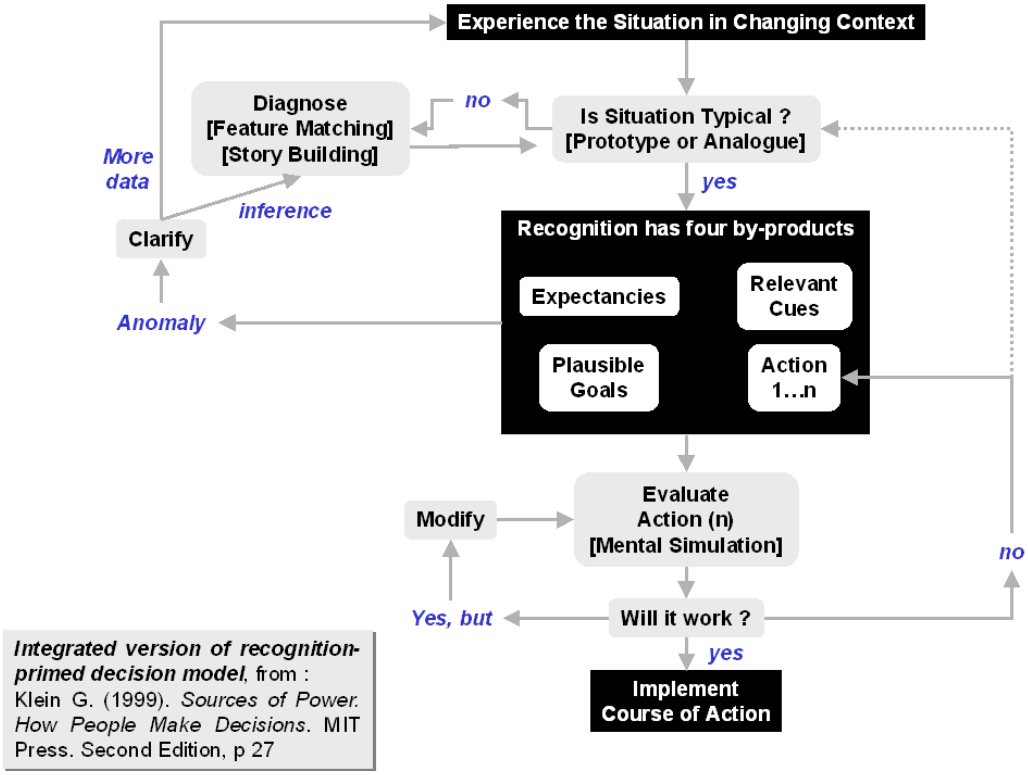


Figure 3 Klein's (1998) integrated RPD Model

NDM Models have limitations, including the Recognition-Primed Decision (RPD) Model, says Klein (1997, p. 15).

Crego & Spinks (1997) reckon that in the course of a singular intervention people resort on several decision-making strategies[139] that are activated within the course of an action depending upon changes in circumstances.

Lipshitz (1997a, pp. 155-156) identified three uncertainty reduction strategies :

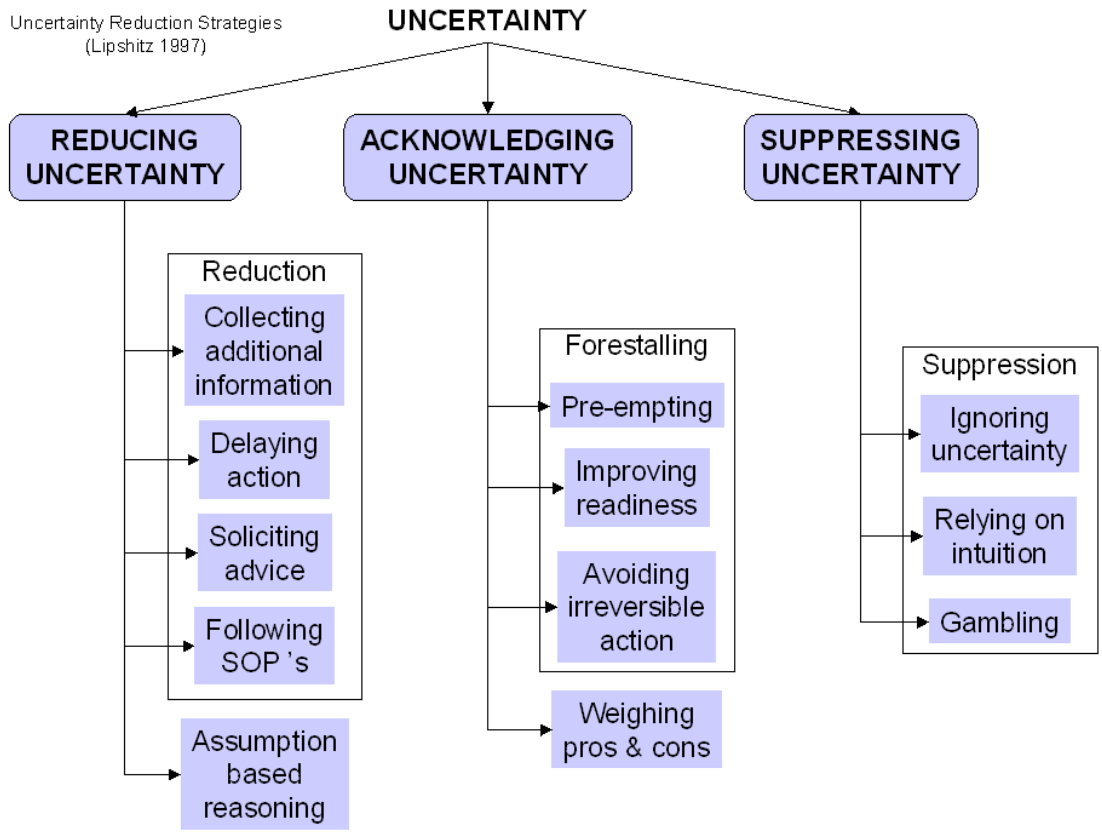


Figure 4 Lipshitz's (1997a) uncertainty reduction strategies

For Lipshitz (1997), these strategies, and more specifically their respective reduction tactics, are mobilised in response to three different forms of uncertainty, namely inadequate understanding, lack of information and conflicting alternatives : forestalling

	Reducing uncertainty	Assumption-based reasoning	Weighing pros and cons	Forestalling	Suppressing uncertainty
Inadequate understanding	X			X	X
Lack of information		X		X	X
Conflicting alternatives			X	X	X

Figure 5 Lipshitz's (1997a) uncertainty reduction strategies vs. forms of uncertainty

Flin et al. (2007)[140], following on the work performed with aircraft pilots by Orasanu & Fischer (1997), showed that the choice of a *decision-making strategy* might depend on two variables : the time available to decide and the level of risk likely to be faced.

For Orasanu & Fischer (1997, p. 352) the DM strategy elected here and then depends on two predominant variables : Is there or is there not time to think ? Does or doesn't the situation at hand present a high risk (present of future) ?

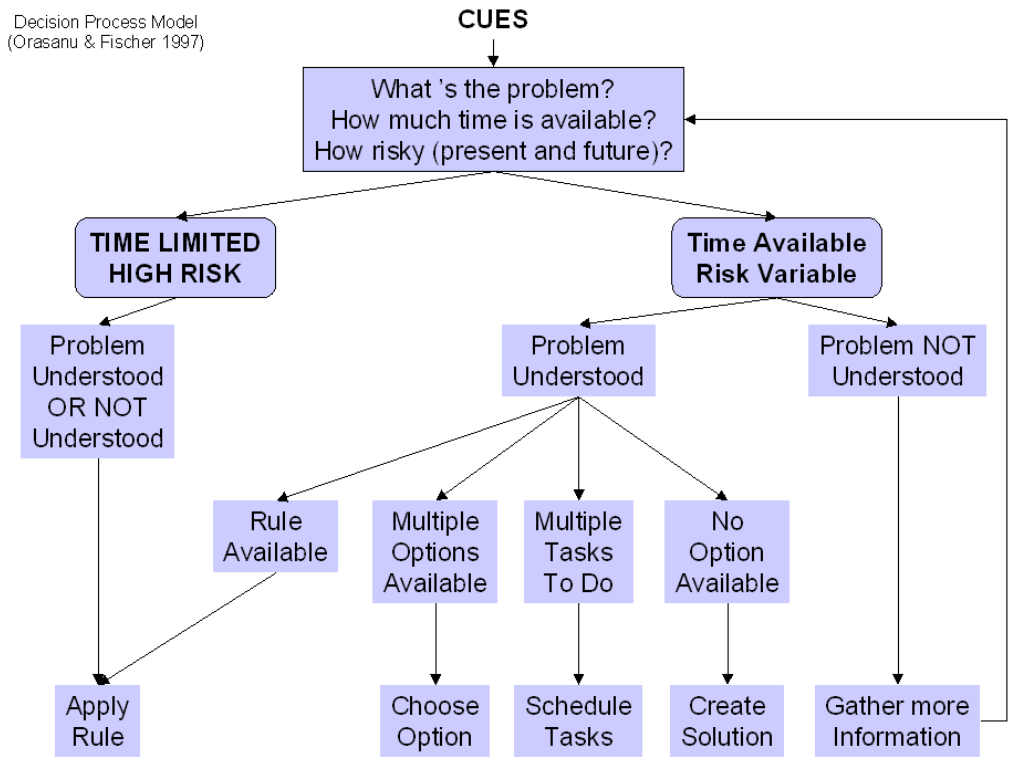


Figure 6 Orasanu & Fischer's (1997) Decision Process Model

So decision-making strategies match specific configurations of the situation. But differences in circumstances and their constant novelty (Crego & Spinks, 1997, p. 90), or in decision-making styles (Crego & Spinks, 1997, p. 92), might not be the only factors that shape the way decisions are made.

4.5. NDM Research and stress

By definition, Klein (1997, p. 19) reminds, NDM Studies have focused much of their work on stressful situations (time pressure, lack of information, multiple-competing goals, etc…) and stress may be a factor of variation in DM strategies.

Based on their analysis of a number of accidents Stokes & Kite (1994) say that stress affects mainly short-term and working memory processes but not long-term memory retrieval processes. Orasanu & Fischer (1997, p. 352) make time pressure and risk the main two variables of situation assessment.

Orasanu (1997) studied the effects of stress on pilots. Situation assessment's cognitive processes are to be affected when cues are unfamiliar or unclear, and action selection's cognitive processes are to be affected when pilots need to actually make the choice of a course of action because no simple routine-like response to the situation is available. Then they are to create ad hoc solutions. In fact, based on Stokes & Kite (1994), Orasanu (1997, p. 55) seems to say that situation assessment is more affected by stressful circumstances than action selection. Situation assessment can be affected in her views by a number of stress-related effects when cues are unfamiliar or unclear :

- Reduced scanning of cues
- Perceptual tunnelling, i.e. focusing on a reduced set of cues while ignoring peripheral ones
- Non-systematic search of available cues.

And when there is time pressure or impending risk, those stress-related effects can be :

- Overestimation of actual threats
- Jumping to premature conclusions.

Action selection can be affected by another set of stress-related effects when choice decisions or creative problem solving are required :

- Task shedding
- Shifting of decision criteria
- Simplifying strategies.

And we understand further that a certain lack of knowledge or of creativity may also affect action selection (Orasanu, 1997, p. 54).

4.6. An NDM theory without emotions ?

Brain studies show that emotion plays a part in decision-making (Vogeley & Fink, 2003) but NDM research has not studied it properly yet (Mosier & Fischer, 2010).

In support of this assertion, the list of the cognitive operations involved in decision-making identified by NDM researchers, and relating either to Situation Awareness (SA) or to Action Selection (AS), shows a rather rational and deliberative picture of decision-making:

Perception of a situation
Margins evaluation (Risk at hand, Time to act)
Diagnosis and recognition of the Situation (what's going on here?, through recall)
Awareness of the problem (what does the situation demand?)
Projection (what's the situation going to look like in the future?)
Awareness of Situational uncertainty (situation or problem or projection not recognised or fuzzy)
Further clarification / diagnosis of the situation or problem (inference, feature matching, story building)
Recall of associated information (cues, expectancies, goals, action options = rules, task set, nothing)
Anomaly detection (discrepancy between recalls and situation or Uncertainty in action options)
Attitude taking (with regard to option uncertainty : ignoring, relying on intuition, gambling, avoiding irreversible actions, wait and see)
Plan elaboration or modification (assumption-based reasoning, weighing pros & cons, eliminating irreversible actions, intuition, option selection, task schedule, creation)
Mental simulation (consistency check)
Probabilistic evaluation of applicability and efficiency vs. Uncertainty
Decision to act (soliciting advice, searching for further information, postponing/delaying, engaging in action as planned)

Table 5 The NDM Cognitive Operations Grid (NCO Grid)

Several inputs from research suggest that the rational, *deliberative* process formed out of these cognitive operations probably does not alone rule the cognitive control of people's performance in the field. Emotions, fear for instance, have both physiological and sensorimotor consequences, like an increase of heart rate, "*phospholipid secretion*", or a decrease of "*secretion of testosterone and other androgens*" (Idzikowski & Baddeley, 1983), and psychological consequences such as inhibition of action or panic (ibid). Slovic et al. (2002) suggest that individuals make decisions through a "*dance of affect and reason*", referring to "*Affective features that become salient in a judgement or decision making process*". And Livet (2002), Thompson (2007), Lazarus (1993)[141] and Lazarus (1993b)[142] assert the key role emotions play in the rationality of decisions made in the course of one's action.

Mosier & Fischer (2010), contrasting *Naturalistic Decision Making* and *Judgement and Decision Making* research currents, summarise the argument.

First, "*Part of the NDM community's reluctance to embrace affect as a component of expert decision making*" may result from a confusion between emotions that are external to the subject's course of action (mere disturbances of the cognitive process) and emotions that are internal to it, *task-related* say Mosier & Fischer (2010)[143], and that are useful in the cognitive process of decision-making : "*integral affect—task-relevant affect—may provide essential cues as well as structure to the decision process*." (p. 242).

Secondly, affects impact on the decision-making process in several ways, research shows (Mosier & Fischer, 2010, pp. 242-243)[144] : as "spotlight" or attention guide (warning sign), as information (emotions become part of the deliberative process), as motivator (toward goals or attitudes, depending on the valence of the appraised situation), or as a frame for evaluating decision outcomes.

Thirdly, affects are triggered by the context of the action performed by the subject : negative affects stem from task difficulty, positive affects from easier tasks (ibid, p. 244).

Four, three hypotheses are formulated as to whether affect plays a role in expert decision-making: 1) "experts are no different from laypeople and will be influenced by their emotions, irrespective of their task relevance or unrelatedness." (p. 245) ; 2) "experts making domain-related decisions are immune to the impact of affect." (p. 246) ; 3) "emotions are not necessarily irrelevant distractions but, rather, may provide valid information about the task at hand." (p. 246).

Five, experts can discern external, disturbing emotions and control them; And they learn the emotional significance of cues, to recognise their emotional reactions as warning signs, and to make sense of situations and possibly be pushed to search for complementary information and further meanings (ibid, pp. 247-249).

Finally, there are several ways in which affects can be fitted into NDM models of decision-making as a result of what precedes (ibid, p. 249-250).

4.7. Macrocognition as attempt for NDM research to find recognition ?

As understood before (Mosier & Fischer, 2010), NDM research has had its critiques and has had to strengthen its role in DM research, indicate Maarten Shraagen et al. (2008).

First, Klein et al. (2000) and Klein et al. (2003) express NDM researchers' will to come into closer touch with cognitive ergonomics. The word "*macrocognition*" was coined by Pietro Cacciabue and Erik Hollnagel (Cacciabue and Hollnagel, 1995) to suggest that the links between the two communities could be reinforced and their interests converge, and "*to indicate a level of description of the cognitive functions that are performed in natural (versus artificial laboratory) decision-making settings*." (Klein et al., 2003). The focus on macrocognition, they say, had now to be the "*mental activities that must be successfully accomplished to perform a task or achieve a goal*" (Klein et al., 2003).

Secondly, de facto trying to broaden the scope of NDM research (Maarten Shraagen et al., 2008, p. 7), after *decades of research* that "*had not led to a discovery of recognitional decision making*" (Klein et al., 2003), Maarten Shraagen et al. (2008) suggest that this shift of focus to macrocognition happened in reaction to three main criticisms : 1) the opposition of Behavioural Decision Making researchers who doubted the originality of NDM studies to which he answers "*NDM also conflicts with the 'heuristics and biases' approach to decision making*" (p. 5) ; 2) the conflict "*with the position of Behavioral Decision Making to formulate strategies and aids that can replace or fix unreliable human judgement*" (p. 5) ; and 3) it "causes discomfort to experimental psychologists" (P. 6) for NDM "*researchers could not confine themselves to particular tried-and-true paradigms*" (p. 6).

Thirdly, macrocognition defines its epistemological choices in the same opposition to the "*reductionist*" approach of experimental psychology scientists who *reduce* cognition to "*assuming cognition's building blocks* and *concocting information processing flow diagrams looking like spaghetti graphs that make little sense*" (Klein et al., 2003). The general methodology used in macrocognition studies is Cognitive Task Analysis (Crandall et al., 2006). This includes (Hoffman, 2008) ethnographic methods (to "*study the workplace and work patterns and conduct documentation analysis. The general approach is called activity analysis or work analysis*."), psychometric methods (to "*measure human performance and conduct cognitive task analysis. This is the general approach of human factors engineering and cognitive systems engineering*"), and sociometric methods (to "*interview domain practitioners, study communication patterns, and reveal social*

networks within knowledge-based organizations. This is the general approach of ethnomethodology, although it overlaps significantly with activity analysis and work analysis.").

In a graph often referred to, Klein et al. (2003) indicate that macrocognition relies upon a conceptual framework articulated around a set of core macrocognitive functions and peripheral macrocognitive support processes. Functions include : naturalistic decision-making, sensemaking / situation assessment, planning, adaptation / replanning, problem detection, and co-ordination. Support processes include : developing mental models, uncertainty management, turning leverage points into courses of action, attention management, mental simulation and storyboarding, maintaining common ground. Again, some of these categories (co-ordination, maintaining common ground) point to the particular interest of NDM researchers for collaborative decision-making especially in computerised environments : "*macrocognitive functions are generally performed in collaboration —by a team working in a natural situation, and usually in conjunction with computational artifacts*." (Klein et al., 2003).

Finally, we must also add a specific interrogation in the context of firefighting.

The view that "*Some of the characteristics of the contexts of interest to NDM researchers are: time pressure; high stakes; dynamic settings; incomplete, unreliable or incomplete information; ill-defined goals; organizational constraints; multiple players; and, experienced decision makers*." (Hutton & Klein, 1999) does not depict faithfully on-scene situations reported by BSPP Firemen. *Time pressure* could be challenged by Firemen as, if they must not drag behind, they are dispatched to tasks that by nature require some time to be processed and the question is not so much to act fast as to perform well, in safety and with tangible results as far as feasible. *Ill-defined goals* is a very contestable premise as BSPP teams and binoms are assigned precise goals and missions.

4.8. Conclusion 1 : The current NDM analytic framework

Previous sections of this chapter help to compile the elements of the current NDM Analytic Framework into a short set of tables. They are :

- The NDM Cognitive Operations Grid (NCO Grid[145]) based on Endsley, Orasanu & Fischer, Klein, Lipshitz :

SA (Situation Awareness / Assessment)
Perception of a situation
Margins evaluation (Risk at hand, Time to act)
Diagnosis and recognition of the Situation (what's going on here?, through recall)
Awareness of the problem (what does the situation demand?)
Projection (what's the situation going to look like in the future?)
Awareness of Situational uncertainty (situation or problem or projection not recognised or fuzzy)
Further clarification / diagnosis of the situation or problem (inference, feature matching, story building)
AS (Action Selection)
Recall of associated information (cues, expectancies, goals, action options = rules, task set, nothing)
Anomaly detection (discrepancy between recalls and situation or Uncertainty in action options)
Attitude taking (with regard to option uncertainty : ignoring, relying on intuition, gambling, avoiding irreversible actions, wait and see)
Plan elaboration or modification (assumption-based reasoning, weighing pros & cons, eliminating irreversible actions, intuition, option selection, task schedule, creation)
Mental simulation (consistency check)
Probabilistic evaluation of applicability and efficiency vs. Uncertainty
Decision to act (soliciting advice, searching for further information, postponing/delaying, engaging in action as planned)

Table 6 The NCO Grid

- The Macrocognition Analytic Framework (MAF), from Klein et al. (2003) :

Macrocognitive Functions
Naturalistic decision-making
Sensemaking / situation assessment
Planning
Adaptation / replanning
Problem detection
Co-ordination
Macrocognitive Processes
Developing mental models
Uncertainty management
Turning leverage points into courses of action
Attention management
Mental simulation and storyboarding
Maintaining common ground

Table 7 The Macrocognition Analytic Framework (MAF)

- The Experts' Characteristics Grid (ExpGrid)[146], based on Hutton and Klein :

Vast domain-specific knowledge
Have superior memory in their domain based on chunking
Perceive large meaningful patterns, or chunks of information, rather than individual pieces of information
Have refined perceptual abilities, namely to see typicality, to see distinctions, and to see antecedents and consequences (through story building and mental simulation).
Spend more time trying to understand the problem, in contrast to the novice who jumps right in and begins to manipulate the surface features of the problem
See and represent a problem at a deeper level, at a causal level rather than at a more superficial level, based on surface features of a problem, and on learned rules as for novices
Attuned to the goal-relevant constraints in the environment which allows to recall information according to, or with respect to, those constraints
Skill being learned to automaticity, do not have to analyse a situation to perform well
Are fast and make fewer errors

Table 8 The Experts' Characteristics Grid (ExpGrid)

- The DM Context Determination Grid (DMContext Grid)[147], based on Zsambok (1997) :

Ill-structured problems
Uncertain dynamic environment
Shifting, ill-defined, or competing goals
Action feedback loops
Time stress
High stakes
Multiple players
Organisational goals and norms

Table 9 The DM Context Determination Grid (DMContext Grid)

Secondly, we understand that though some account for the variability of cognitive processes of decision-making, NDM models do not integrate emotion. They are essentially *deliberative*[148], rational information processing models. The emotion coping process synthesised in chapter 2 suggests links with the cognitive operations described in NDM and Mosier & Fischer (2010) have suggested different types of such connections.

4.9. Conclusion 2 : Decision-Making-in-Action (DMA) as working concept

For the need of this research, we define *Decision-Making-in-Action* (DMA) as the individual cognitive process that controls a subject's performance within the course of a given, delimited, situated, embodied and enacted action performed in the field, not in a laboratory :

- The concept of DMA is established to precisely identify our object of research among other objects in NDM research, in which decision-making may cover a wide spectrum of decision-making configurations, from individual to collaborative, from laboratory and simulation to field settings, from operational to tactical decision-making.

- DMA does not exclude the fact that the subject may interact with others and objects in the course of his action. Only, these interactions are considered from the personal *subjective* perspective of the performer, the central subject under study. Interactions with others are information inputs from them or outputs destined to them within the frame of specific cognitive operations performed by the subject himself. Others' cognitive activity and its processes remain unknown to the subject beyond these interactions.

- In this thesis, cognitive is understood in a very broad sense and thus includes emotion and metacognition as well as motivation, cognition usually understood as information

acquisition and processing, memory, imagination, etc…, which are all “mental” operations. Cognitive here equates to Mental.

- DMA may include any cognitive operation that can be performed by a single individual.

4.10. Conclusion 3 : Peritraumatic resilience as a metacognitive outcome of DMA?

PTR mobilises three capabilities : getting-by, resisting and resuming. These capabilities can be seen as metacognitive processes. If we posit that PTR is the achievement of an individual’s cognitive process of Decision-Making-in-Action, then, in the context of Critical Incidents, DMA would be “*successful*” when it manages to yield PTR. One way to look at PTR is to ask if these capabilities are metacognitive functions in the sense of an “executive” cognitive loop (Cox, 2005) noticing difficulties at hand and promoting solutions to resolve them.

What is metacognition ? If the hypothesis that it is an important factor of peritraumatic experience in DMA is true, can fire-fighters be trained to develop ad hoc metacognitive skills ?

The next chapter presents the functional principles of metacognition. It also presents how metacognitive training could be used to prepare fire-fighters to CIs.

CHAPTER 5. Metacognition, metacognitive training and CIs

This chapter defines metacognition. It discusses whether metacognition is only a learning-related capacity or if it can be associated with the real-time control and adaptation of cognition in action. We present metacognitive training and its place in NDM research, and expose the starting points to the engineering of metacognitive training. In conclusion, we present a metacognitive training framework meant to prepare fire-fighters for potential CIs.

5.1. An initial definition of metacognition

Metacognition is a long known[149] topic well studied in NDM research. Cox (2005) defines it as "*cognition about cognition*". Schraw & Moshman (1995) define metacognition as "*knowledge of one's own cognition*".

Also referred to by Spear-Ellinwood (2008) as "*thinking about thinking (Bialystok[, 1992, 2001][150] ; Thompson & Thompson, 1998[151] ; Tomasello, 1999[152])*", metacognition has been essentially envisaged from an educational perspective : "*'Metacognition, or the awareness and regulation of the process of one's thinking, has been recognized as a critical ingredient to successful learning' (Lin, Schwartz, & Hatano, 2005, p. 246[153]).*" (p.3), or else "*Metacognition then includes the ability to assess one's cognition and "to manage further cognitive development" (Rivers, 2001, p. 279[154]).*" (Spear-Ellinwood, 2008, p. 4). In that sense, metacognition is related to the process of learning, not to the real-time control of cognition in action.

Sun et al. (2006)[155] and Downing et al. (2007) indicate that metacognition can be a conscious or a non-conscious (pre-reflexive) cognitive process[156]. And Schraw & Dennison (1994) underline that "*metacognitively aware learners are strategic and perform better than unaware learners*".

5.2. A controversy about the idea of a "meta" cognition

The frontier between cognition and metacognition, however, can sometimes be thin (Cox, 2005, p. 105). In this vein, Tharp & Gallimore's (1985) "*neo-behaviourist ?*"[157] perspective discards the idea of a "meta" cognition. Their views are :

1. The knowledge of the theoretical rules behind practical know-how is derived from experience[158].

2. Therefore, learning how to do things derives only from practice, not from theoretical teaching[159].

3. Teaching rules is pedagogically useful only to novices[160].

4. A central question is whether we can cognitively train people to know how to do things in a wide variety of contexts, what they call generalisation[161]. Under this line of thoughts, the authors suggest the idea that people can be trained to improve their capacity to make decisions in action, in the field[162].

5. In fact, the authors question the very possibility to speak of "meta" cognitive training[163].

5.3. Metacognition as a process of continuous learning

For Spear-Ellinwood (2008), not limited to childhood, metacognition is a learning process spanning into adulthood (Spear-Ellinwood, 2008, p. 5) of continuously resolving discrepancies between one's knowledge and how the world works. A mediation "*between what people think they know and how the 'world' works*" (ibid, p. 5), metacognition "*refers to children's acquisition of tools of self-regulation, self-planning, self-monitoring, self-checking and self-evaluating*" (ibid) that helps them resolve this "*dissonance*", i.e. "*disruptions are viewed as moving forces in a cycle of internalization and externalization where people 'construct new instrumentalities', and engage in the 'transformative construction of new instruments and forms of activity as collective and individual levels'" (Daniels, 2001, p. 92-93[164])*" (ibid).

Quoting Goos, Galbraith, & Renshaw (2002)[165], the author extends the definition of metacognition to make it a *social interaction* process allowing students to "*[think] about and [reconsider] one's own and others' thinking*." (Spear-Ellinwood, 2008, p. 5), and to "*increase students' abilities to see the problem from another's perspective, to rethink their own, and to analyze and resolve the dissonance between them*." (ibid).

This idea of learning from resolving discrepancies, either individually or through social interactions, can be viewed as a foundation of the development of *expertise* conceptualised by NDM researchers and "*What sets apart an expert learner from a novice learner is the development and use of metacognitive strategies*" (Spear-Ellinwood, 2008, p. 13).

Kapa (2007) describes the loop-like process of real-time mathematics learning and shows a complete integration between cognition and metacognition :

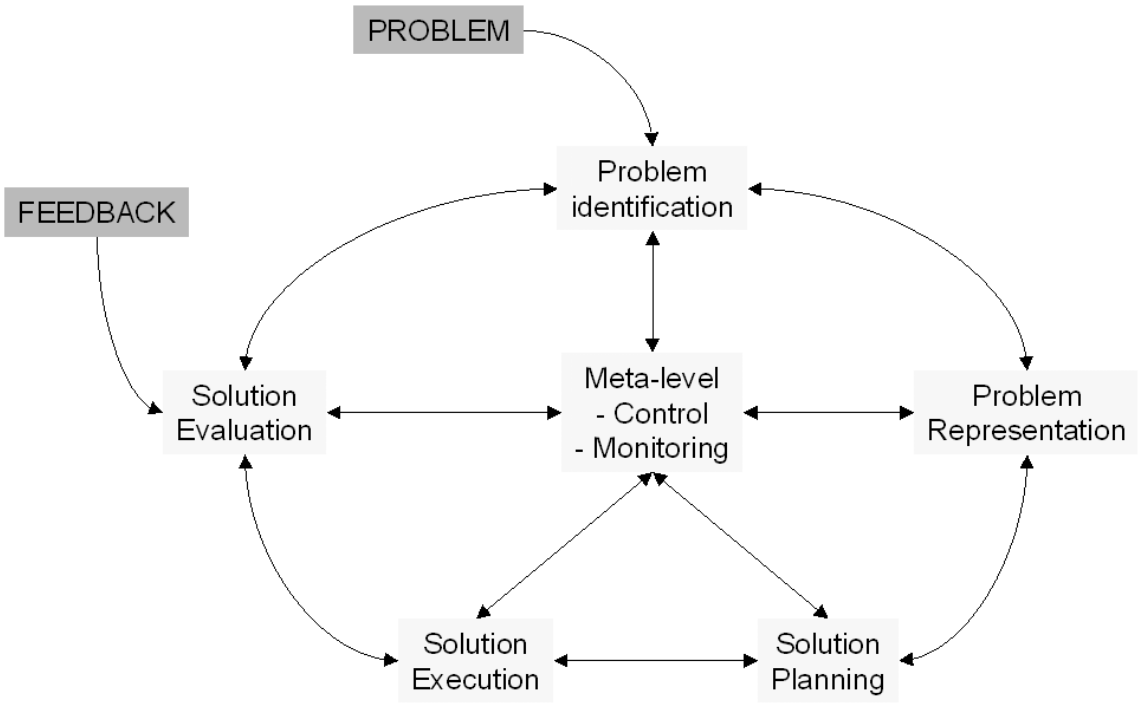


Figure 7 Real-time metacognitive process, after Kapa (2006)

The idea of a metacognitive loop has been described also by Anderson et al. (2006). It is a three steps process : noticing the existence of a problem to solve, assessing options to deal with the difficulty, and guiding the option into action (p. 388). Similarly for Spear-Ellinwood (2008) metacognition mobilises five activities : *'thinking about the learning process, planning for learning, monitoring of comprehension, or production while it is taking place, and self-evaluation after the learning activity has been completed'"* (p. 13).

5.4. Metacognitive learning, training and provocative strategies

Schraw & Dennison (1994) suggest metacognition is based on two functions and their respective subfunctions[166] :

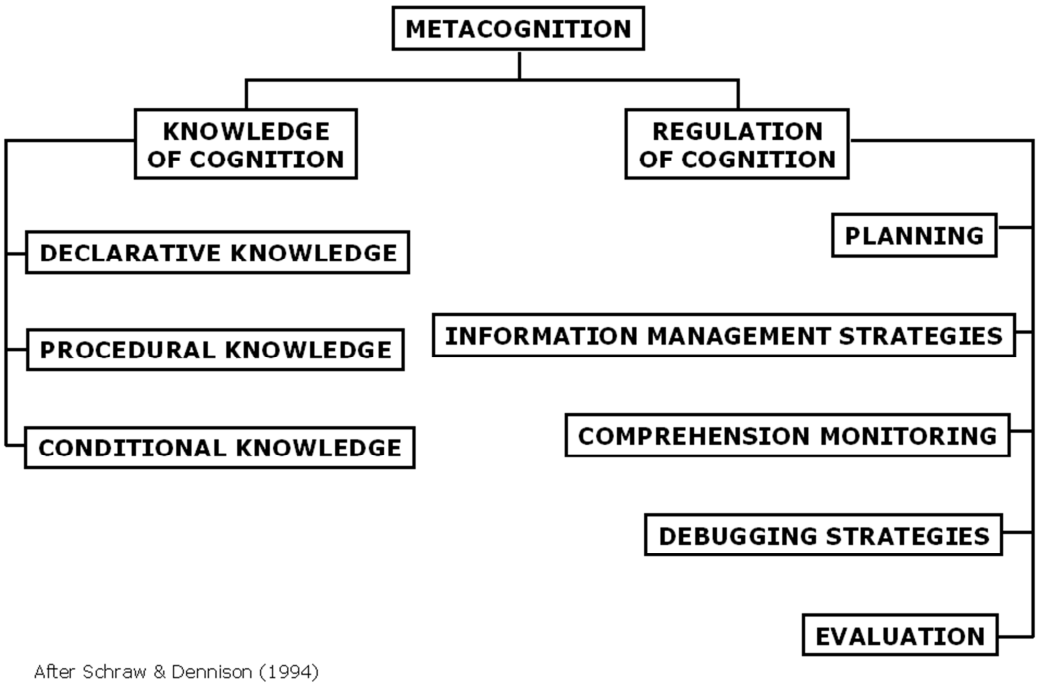


Figure 8 Metacognition and its functions (Schraw & Dennison, 1994)

These functions, or elements of metacognition, are themselves the result of a process of metacognitive learning. What metacognitive learning does is to help people develop their capacity to regulate their cognition on the basis of their acquired knowledge and in turn metacognitive skills help reinforcing their knowledge (Spear-Ellinwood, 2008). This process, she says[167], relies upon three domains, knowledge, ability and awareness, each feeding the next one at the non-meta level, and metacognitive learning transforming the contents in each domain into a capacity to regulate cognition.

Downing et al. (2007) add that in this process of improving their metacognitive skills individuals develop heuristics : "*For example, how they plan, set goals and process feedback*" (p. 3). In the case of stress handling (Carver et al., 1989), two coping strategies have been identified in research : *problem-focused coping* and *emotion-focused coping*. These strategies can be considered as metacognitive heuristics. These heuristics are tested in the context of episodes of action and adjusted through the process of discrepancies resolution mentioned by Spear-Ellinwood (2008).

The following diagram summarises the process of metacognitive learning :

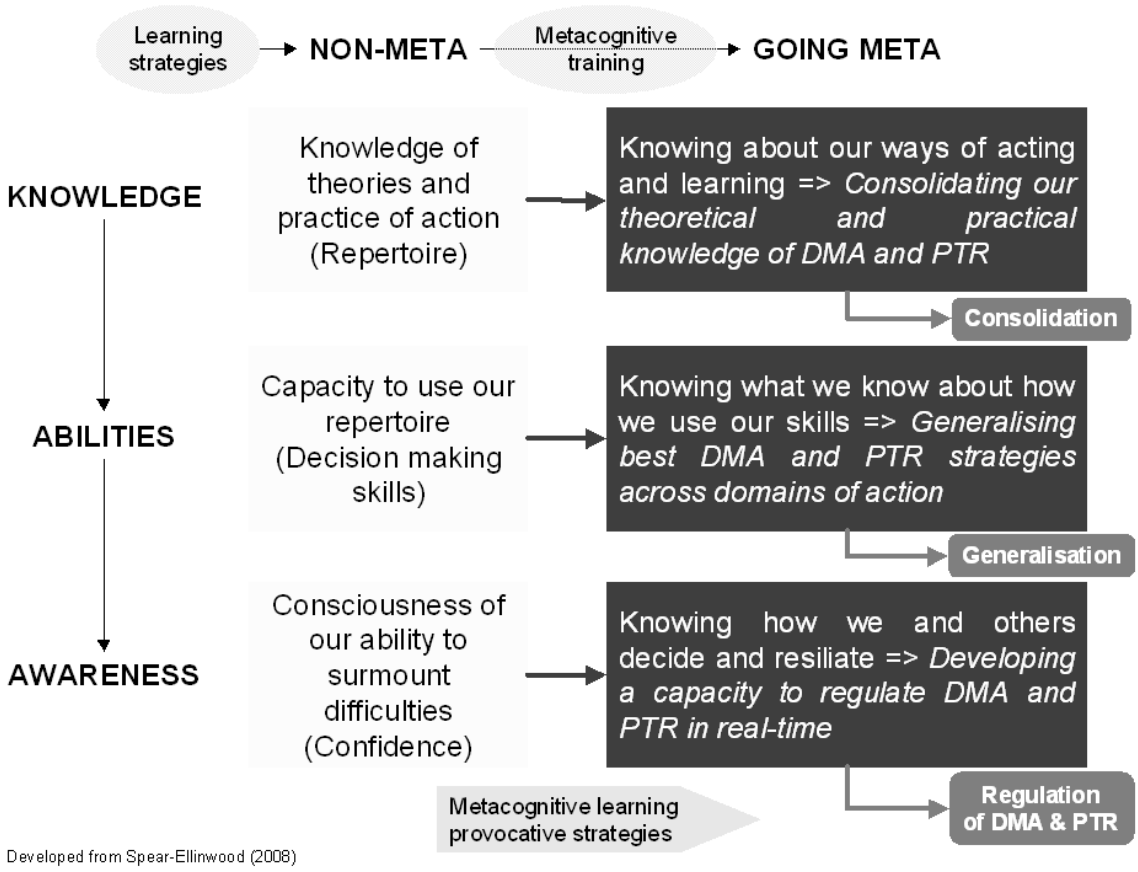


Figure 9 The levels and process of metacognitive learning

Knowledge is the founding stone of the edifice at the non-meta level : a novice must first develop his repertoire of theoretical and practical knowledge. Then, practice in the field will gradually help the individual to develop his *abilities* to use his repertoire of knowledge in order to make decisions. More experienced people become *aware* of their ability to make the decisions that allow them to surmount difficulties they encounter in action.

"Going meta" (Spear-Ellinwood, 2008) is the process of metacognitive learning that allows the individual to move up a level of abstraction of his own knowledge and know-how. Following the same three levels of development of his capabilities, metacognitive learning first takes metacognitive learners to consolidate their knowledge into a "meta-knowledge", i.e. a capacity to draw from the variety of pieces of knowledge and practical experience the common and general patterns and rules. Once this is accomplished, the subject can generalise his knowledge and abilities to a variety of fields of action. Especially with DMA and PTR, the cognitive and social mechanisms on which the individual resorted in specific episodes of action are tested or questioned against the particulars of other domains of action. "Meta-abilities" are thus elaborated that allow people to apply common DMA and PTR processes to a variety of circumstances. Finally, when this is accomplished and the individual has extended his understanding of DMA and PTR mechanisms across a wide

variety of circumstances is he able to develop ways to regulate, i.e. to adapt his cognitive processes to even surprising circumstances. This “meta-awareness” of the cognitive requirements of novel situations is here considered the ultimate stage of development of one’s expertise.

Metacognitive training is the process that presents provocative learning strategies (Spear-Ellinwood, 2008) to metacognitive learners. Designing metacognitive training schemes equates to elaborating a process in which *metacognitive learning provocative strategies* (Spear-Ellinwood, 2008) will trigger the interest of the learner and push him to take the next step toward what appears as the ultimate goal of this : the metacognitive regulation of cognition, in our case of DMA and PTR.

Spear-Ellinwood (2008) suggest, in the context of the design of scientific exhibits for the Arizona University’s Science Center Exhibition, to use a variety of metacognitive tasks and associated metacognitive training tools such as :

- *Guided mastery* : the visitor of the exhibition uses some tool to solve a problem, and video recording to keep trace of his doings and later identify how he solved it. Then the same visitor records his explanation and becomes a master guide to other visitors to transmit his knowledge.

- *Storytelling* : the visitor confronted with an exhibit creates a story. Then he must present it to other and therefore has to think of how to transmit his ideas to others and chose specific forms and words for this. Eventually, listeners will engage into collaborative storytelling and thinking aloud.

- *Metamemory games* : the visitor is confronted to symbols such as  (an ambulance) and asked to choose a mediating symbol within a selection (for instance : ) that evokes episodic memories of circumstances in which he encountered an ambulance. Being asked why he picks-up a given symbol, for instance the snowy road in the occurrence of a car accident the symbol of his explanation is presented to him, for instance  he was having a conversation with the passengers of the car and was distracted. Etc. This process raises the visitor’s awareness of the chain of events and cognitive operations that led to come across the ambulance.

- *Re-imagining experiences* : once the visitor has successfully performed a task he is asked to imagine the way he would apply his acquired knowledge in another problem-domain. This helps the visitor to generalise his cognitive models and processes.

- *Simulation (going through an episode of experience)* : the visitor is invited to use games (video or more classic games) to share an experience with others and discover their goals, intentions and perceptions, thus helping him to understand how others think and act and inviting him to reconsider his own ways of thinking and acting.

- *Dissonance & harmony analyses* : the visitor is presented a problem containing intellectual contradictions and conflicts and his led to experience his self-imposed limitations for instance.

- *Narrating neuro & bio feedback* : the visitor is asked to remain relaxed, focused and alert. While they keep trying to maintain such a state they learn about the thoughts and behaviours they had. Asked their feedback after the experiment they discover how they control their behaviour or even their neural and biological functions.

- *Making explicit implicit cognitions* : through a think-aloud while the visitor performs a the task or afterward. This raises his awareness of the cognitive operations he performs, the resources and information he uses, etc.

- *Evocative object* : the visitor is asked to take a picture of an exhibit and to tell the story associated with it, what the object makes him feel or think of. Then he is asked to explain what made him draw these connections. This task reveals the subject's cognitive background. The visitor can be invited to draw the concept map associated with his evocations.

Within a process of Exposure to an artefact → Generation of metacognitive learning thoughts → Reflection → Adjusting, these provocative strategies serve the second stage.

The metacognitive learning process we presented here minimises Tharp & Gallimore's (1985) objection to "meta" cognition as we clearly show that "going meta" means developing monitoring and regulating mechanisms. Also it takes account of their view that knowledge develops with practice.

What we posited in this section also moves the focus of metacognition from learning and education to the real-time regulation of cognition.

5.5. Metacognition as real-time regulation of cognition

For Cox (2005) action, cognition and metacognition rather constitute three complementary levels of human experience : metacognition monitors and controls cognition, and cognition monitors and controls action.

Anderson et al. (2006), in their article on metacognition in autonomous agents, define "*metacognitive monitoring*" as the "*ability of [an artificial intelligence based] system to self-monitor its own decision-making processes and ongoing performance*". In artificial intelligence, metacognitive functions can be fitted into computer systems to develop their tolerance to perturbations, defining "*an anomaly as a deviation from expectations for performance or outcomes*" (Anderson et al., 2006, p. 389) : "*there is some empirical evidence for the importance of metacognition in dealing with the unexpected or unfamiliar*." (p. 388) and their view is "*to equip artificial agents with MCL: the ability to notice when something is amiss, assess the anomaly, and guide a solution into place*" (p. 389). Cox (2005), for instance, also highlights the vast interest of artificial intelligence research for metacognition (p. 106).

Secondly, as seen in the previous section metacognitive training can help individuals and teams to better deal with challenging situations, improve their safety on the line of duty, and develop their expertise. And this is also a focus of the present research.

Effective decision-makers have "*a repertoire of decision making strategies that they can draw in response to particular situational clues*" (Cannon-Bowers & Bell, 1997, p. 101). They are "*adaptive*" (p.102), i.e. capable of engaging "*in a continual process of strategy assessment and modulation*" (ibid). "*Expert decision makers appear to be better [than novices] able to monitor their own processes during decision making*" (p. 105), which they deem a "*[crucial 'executive' function] as the problem changes and evolves*" (ibid). If experience provides this kind of expertise, we may think it can be enhanced through training schemes that develop people's metacognitive learning and regulation. Omodei et al. (2002) suggest that methods for reducing errors include "*both the systemic level by redesign of the decision environment and […] the human level by the implementation of specific training strategies*". And Schraw & Dennison (1994)[168] point to the use of metacognitive training to better control stress in action.

5.6. How is metacognition taken into account in NDM research ?

Globally NDM research takes account of metacognition in that sense that decision-makers are recognised to adapt their strategies to situations at hand. Orasanu & Fischer's (1997) Decision Process Model is based on problem detection and describes how the subject responds to problems. Lipshitz's (1997a) uncertainty reduction strategies constitute another answer to the question. Klein's (1998) integrated RPD Model embeds several features (typicality, feature matching, mental simulation) that can be broadly assimilated to Anderson et al.'s (2006) metacognitive loop. But this positive answer can only be provided to the extent that the frontier between cognition and metacognition is kept fuzzy and that we accept NDM or macrocognitive functions or processes as metacognitive.

5.6.1. Current views on metacognitive training, its goals and principles

For Driskell & Johnston (1998) one of the major goals of NDM studies is to prevent decision-making errors under stressful conditions. Metacognitive training is one of the possible ways to achieve this goals. Metacognitive training is performed *post-action* to enhance *in-action* metacognitive skills.

"*NDN-consistent training*" (Cannon-Bowers & Bell, 1997, p. 100) is "*a mechanism to support natural decision-making processes, and […] a means to accelerate proficiency or the development of expertise*".

Cannon-Bowers & Bell (1997) conclude that "*the value of NDM theories in designing training lies in what they have to offer regarding knowledge, skills, and processes that underlie expert performance*" (p. 103). Metacognitive training, in their view (p. 106), must improve decision makers' skills in three areas : the self-assessment of one's cognition, the selection of a decision-making strategy, and the effective management of knowledge resources.

Prior views suggest that metacognitive training is performed post-action either individually or collectively, consciously or not :

- After an action has been performed metacognitive learning may be individual and non-conscious, during Long-Term Memory consolidation periods, like sleep, and consolidation develops associations between remembered items of experience, either with other such items or with semantic knowledge.

- It may also be individual and fully conscious when the subject, used to the practice of retrospective metacognitive reflection, consciously looks back at his just-past experience, tries to make sense of it and to draw lessons.

- Metacognitive training can also be collective and focused on one individual : coaching, as practised in business organisations, may be seen as a form of metacognitive training.

- Collective sessions can be based on cross-training principles (Blickensderfer et al., 1998), with a view to enhance specifically collaborative metacognition.

For Batha & Carroll (2007), a typical a posteriori in-training "*Metacognitive strategy instruction*" is problem-based and includes :

1) *Translation* : Read the question/problem, Ask yourself if you understand the problem – re-read until you do, Identify and paraphrase the main information in the question/problem ;

2) *Integration* : Ask yourself what information you need to make a decision, Ask yourself if you have all the information necessary to make a decision, Ask yourself if you know how to integrate and organise the information ;

3) *Solution planning* : Think out a strategy detailing how many steps and operations are needed to make a decision, Appraise why that strategy is the most appropriate, Ask yourself what would happen if you used an alternate strategy, Check after every step to make sure that the strategy you are using is the most appropriate ;

4) *Solution execution* : Revise your computation to check for errors or missed information, Ask yourself if you have made the right decision.

Cannon-Bowers & Bell (1997) prescribe five metacognitive training techniques :

- simulations,

- guiding novices' practice and insisting on delivering a feedback on their doings,

- embedding training tools within people's work environment,

- cognitive apprenticeship by which an apprentice works closely with an expert,

- and multi-media presentations.

5.6.2. Metacognitive training for stress handling

Driskell & Johnston (1998) indicate that SET, *Stress Exposure Training*[169], "*is an effective method for reducing anxiety and enhancing performance in stressful environments [and encourages] further application and research*" (p. 213). In this context, metacognitive training pursues three goals :

- first, to convey a knowledge of the stressful environment in which people are likely to operate,

- secondly, to develop decision-making skills with a particular emphasis on the effects of stress that can be noticed and recognised in the course of action (physiological changes, emotional reactions, cognitive effects, longer reaction times or changes in social behaviour),

- and thirdly to build people's confidence in their ability to perform under stress (pp. 192-194).

All stress-regulation training is not aimed at handling stress in action. For instance, Berking et al.'s (2010) Integrative Training of Emotional Competencies (iTEC) for emotion-regulation is mainly aimed at preventing mental illness in police officers and their families (Berking et al., p. 331).

5.6.3. Existing schemes for metacognitive training for CI

Studies on how to prepare fire-fighters to the prospect of Critical Incidents in action are scarce. Meredith et al. (2011) have analysed 23 resilience programs aimed at US military personnel. Their goal is to help "*individuals to incorporate resilience factors into their daily lives*" (p. 8). They target military personnel and their families and seek to increase their psychological fitness and readiness for combat (p. 6) by reducing the adverse impacts of the "*mental health conditions and cognitive impairments that affect many service members*" participating in field operations (p. 1). However, these programmes address psychological troubles at the post-traumatic stage and therefore do not correspond to the

need to train fire-fighters to surmount CIs during the time of their intervention, the peritraumatic stage.

Keenan (2008) proposes five "*Key things to be included in pre-incident training &/or information on the subject of work-related traumatic incidents for firefighters and officers*" :

- Critical Incident Stress Identification (CI) : i.e. training or information about the identification and understanding of traumatic reactions and the nature of incidents that have the potential to trigger traumatism. It includes : the nature of incidents that might constitute "critical incidents" or "traumatic incidents" for self and others, the range of potential reactions to a critical incident – including immediate and delayed effects, how to recognise signs of traumatism.

- Critical Incident Stress Management (CISM) : i.e. the ways to manage reactions to trauma exposure. It includes : how to protect oneself during a critical incident, how to cope with reactions to a critical incident while still at the incident scene, how to manage (or "deal with") reactions following a critical incident.

- Managing and/or supporting others (MO) : i.e. how to manage and/or support others during and after a critical incident. It includes : how to recognise signs of critical incident stress in others (individuals and crews), how to be a supportive colleague or supervisor, how to help others.

- Partner involvement (P) : i.e. recognising the role of partners in identifying and managing traumatic or critical incident stress reactions. This includes teaching partners to identify critical incident stress reactions, providing partners with information about the nature of help available to their firefighter or officer and how it can be accessed, the effect on partners and families of a firefighter or officer suffering from critical incident stress, the importance of fire-fighters and officers advising their partners when they experience reactions to a critical incident for understanding and support.

- Reality based training (RT) : this aims at providing exposure to graphic material, discussion, or experiences that demonstrate the realities of the job and what fire-fighters might come across on the line of duty. It includes : visits to the morgue to view dead bodies, visual aids showing dead or injured bodies, discussions or scenarios about

horrific incidents, death or injuries, material such as photos, videos or other materials are used to introduce personnel to what they might experience on-the-job, even if there is no explicit comment that indicates this material to be of a graphic or otherwise potentially distressing nature.

5.7. Conclusion : Metacognitive training for CIs requires a model of DMA and PTR

The frameworks presented in the present chapter recommend measures that apply mainly to the post-traumatic stage of the experience of CIs, and less to the peritraumatic one.

Also, there are differences in ambitions with regards to the conceptualisation of metacognitive training. Where Keenan's (2008) propositions are fed with outputs from fire-fighters' field experience, Spear-Ellinwood (2008) rather propose a general, conceptual mechanism to take people to "go meta".

In any case, CI metacognitive training can only rely upon the development of an individual intimate cognitive experience of CIs. Hence the need for methodological principles and tools that help to present such an experience in an admissible form. Several points must therefore be taken into account to secure the acceptability and success of a metacognitive training scheme targetting the peritraumatic stage of the experience of CIs :

- Cannon-Bowers & Bell (1997) highlight the fact that "*the task of generating cognitive training principles consistent with NDM is not as straightforward as it may seem*" (ibid)[170] and that for metacognitive control to be effective, it must be founded on a clear model of experts' performance. For instance, Omodei et al. (2002) suggest such a model, the Adaptive Control Model. Regarding the experience of CIs, we need cognitive data from which models of DMA and PTR can be derived to drive the design of CI metacognitive training schemes, and in particular of metacognitive learning provocative strategies.

- A second aspect, not addressed in the elements of literature presented earlier, is the capacity of individuals to reflect on their own experience in order to get into closer touch with their cognition. For Downing et al. (2007)[171] individual metacognitive skills develop only to the extent that the subject admits to perform some kind of introspective reflection upon his inner experience, and to transfer the acquired knowledge to other tasks.

- Thirdly, a well thought off process for preparing, delivering and assessing CI metacognitive training is required (Driskell & Johnston, 1998). First, as it must focus on the peritraumatic stage, there are limits to what can be included within such training schemes that deal with deep human emotions. Secondly, to be effective such metacognitive learning must occur only within supportive social processes organising *interactions with peers* and based on *instructional strategies* (Downing et al., 2007)[172].

The fundamental question posed by the need to design CI metacognitive training schemes therefore lies with the capacity of researchers to dig out the cognitive material required to elaborate the models upon which such schemes can be built. It is a methodological question.

The next chapter reviews the methods used in NDM and, showing that they do not match the requirements of the present research, presents the methodological foundations of this study.

CHAPTER 6. From NDM methods to first-person approaches

The study of naturalistic decision-making must take into account cognition[173] as well as emotion and their respective roles in the control of people's performance in critical circumstances. This chapter presents the methods used in NDM research to study cognition. We perform a detailed review of Cognitive Task Analysis and of the Human Factors Interview Protocol in the context of our research. The uniqueness of our case requires a first-person methodological approach to capture retrospectively the details of the subject's episodic memory, rather than an experimental protocol. We present the psychophenomenological foundations of our methodological approach. The chapter concludes on the description of our research object, an *episode of experience*, and on the general structure of the cognitive experience as it can be recalled and narrated by a subject.

6.1. Cognitive Task Analysis and other methods used in NDM research

6.1.1. Panorama of methods used in NDM studies

A number of methods have been developed and used by NDM researchers. Among them (Klein & Hoffman, 2008 ; Maarten Shraagen et al., 2008) stands Cognitive Task Analysis (CTA). Rassmussen (1985) explains that it was developed along with the evolving complexity and criticality of systems and the required level of interaction between computers and their users, stressing the emergence of situations users would not be prepared for and in which uncertainty as to their causes and impacts would be high.

Hoffman (2005) presents the variety of methods included today under the CTA umbrella :

- Bootstrapping methods : They are used to allow the researcher to familiarise himself with the domain he studies. They include : documentation analysis, the Recent Case Walkthrough (a simplified version of the Critical Decision Method), the Knowledge Audit, and Client Interviews.

- Proficiency scaling methods : They are used to distinguish levels of proficiency of people working within a given domain (Naïve, Novice, Initiate, Apprentice, Journeyman, Expert, Master, from the lowest to the highest level). They include : Career Interviews, Sociogrammetry, Cognitive Style Analysis.

- Workplace observation and interview methods : They are used to study how people carry out their work in their domain under a variety of perspectives, including the workspace where individuals and groups work, activities carried out by people, roles and jobs, decision requirements, action requirements, and standard operating procedures.

- Methods for modelling practitioners' reasoning : They include :

    - Protocol Analysis (usually associated with TAPS – Think Aloud Problem Solving) to study experts' cognition in particular problems, cases or challenges. It resorts on various coding schemes such as the Abstraction-Decomposition scheme, the Coding of Proposition for a Model of Knowledge scheme, the Coding of Leverage Points scheme, or else the Coding of Unstructured Interviews to Identify Rules for an Expert System.

    - The Goal-Directed Task Analysis to explore the knowledge and key pieces of information needed by task performers as well as cues and situations that dictate a shift in priority.

    - The Cognitive Modelling Procedure to elicit *quicker than with other methods* the reasoning model of experts working in a given domain by starting from a general model and presenting them with some bogus models that experts tend to correct.

CTA methods are usually based on *structured interviewing and task retrospection*, say Maarten Shraagen et al. (2008, p.6). In this line of thoughts, Dekker (2002) relates the "*questions Gary Klein and his researchers typically ask to find out how the situation looked to people on the inside at each of the critical junctures*" (p. 71) in retrospective verbal reporting approaches :

Cues	What were you seeing ?
	What were you focusing on ?
	What were you expecting to happen ?
Interpretation	If you had to describe the situation to your fellow crewmember at that point, what would you have told ?
Errors	What mistakes (for example in interpretation) were likely at this point ?
Previous experience / knowledge	Were you reminded of any previous experience ?
	Did this situation fit a standard scenario ?
	Were there any rules that applied clearly here ?
	Did you rely on other sources of knowledge to tell you what to do ?
Goals	What governed your actions at the time ?

	Were there conflicts or trade-offs to make between goals ?
	Was there time-pressure ?
Taking action	How did you judge you could influence the course of events ?

Table 10 Gary Klein's questioning approach related by Dekker (2002)

CTA methods is to find ways to help users make decisions in tough circumstances, when everything is not nominal, and to design systems in order to facilitate this process by giving the interaction between computer and operators characteristics matching the pattern of the operators' cognitive functioning under such circumstances. Rassmussen's (1985) "*Schematic map of the information processes involved in a control decision*" represents the logic of decision-making under a variety of circumstances and its underlying principles : rule-based shortcuts, when situations are easy to handle and the operator has the ad hoc cognitive routines ready ; knowledge-based analysis, when situations at hand are unclear ; and knowledge-based planning, when solutions have to be constructed ad hoc as ordinary routines and answers are insufficient.

Other methods have been used in NDM research like :

- Observations of exercises (Pascual & Henderson, 1997).

- Quiz and questionnaires, used in Aviation for instance by Stokes, Kemper & Kite (1997).

- Simulation : Orasanu (1997, p. 47), like many other researchers (see for instance Roth's article in the same volume), evokes simulation as a means to elicit decision-making strategies while Maarten Shraagen et al. (2008) point to its difficulty as it has "*to reflect key challenges of the task and engage practitioners in realistic dilemnas*" (p. 6). It is sometimes prepared well in advance (Hutchins, 1997)[174]. Waag & Bell (1997) used simulation in combination with Woods' (1993) Behavioural Protocol, involving two Subject Matter Experts (SME's) whose judgements and observations of a simulation training session were "*the most important data sources*".

- The Impromptu Recall Technique and the Verbal Protocol Technique described by Bisseret et al. (1999).

6.1.2. Protocol Analysis

Protocol analysis is not designed for idiographic studies of cognition. For Hoffman (2005, p. 65), Protocol Analysis is fundamentally a "*data analysis method*" rather than, as often said, a "*research method*"[175], used to "*conduct a study in which expert's performance at their familiar tasks is examined*" (P. 65). For Ericsson & Simon (1984) Protocol Analysis is aimed at studying "*cognitive processes used during many trials of an experiment*" (ibid, pp. XII, 151).

A *protocol* here is "*a record of a process in which a domain practitioner has performed some sort of task.*" (Hoffman, 2005, p. 65).

To collect data, Protocol Analysis resorts either on *Think-Aloud Protocols* (TAP) or on *Retrospective Verbal Reports* (Ericsson & Simon, 1984, p. XVI). For Hoffman (2005), Think-Aloud Problem Solving (TAPS) knowledge elicitation "*can be more revealing than observing experts solving common or routine problems (Klein and Hoffman, 1993).*" (p. 66).

In Protocol Analysis, data processing includes :

- Coding statements based on pre-defined categories that reflect the goals of the research (Hoffman, 2005, p. 66)[176].

- Clustering identified categories (Hoffman, 2005, p. 66)[177].

Some of the main characteristics of *Retrospective Verbal Reporting* in Protocol Analysis are (Ericsson & Simon, 1984) :

- The Model is based upon STM (Short-Term Memory) for Think-Aloud Protocols, and on LTM (Long-Term Memory) and Episodic Memory for Retrospective Verbal Reports (ibid, p. 149). Retrospective recalls are facilitated by cues stored in STM that are usable if recalls are performed immediately after the task (ibid, p. 149) with a risk that STM being very volatile gaps in retrospective memories may appear (ibid, pp. 168).

- The authors formulate a number of criticisms (ibid, p. 61) of retrospective verbal reporting (it affects performances, it may be incomplete, and it might refer to unlooked

for cognitive processes), but undermine these difficulties (ibid, p. 62) as they can be overcome.

- Retrospective Verbal Reporting relies upon the idea (ibid, p. 150) that "*questions can be answered by direct retrieval of the information only if the subject has, during his performance of the task, already generated this kind of general description of his own cognitive processes*", as the subject encodes the elements characteristic of his performed action while he performs it (Zimmer, 2001 ; Mayes & Roberts, 2001 ; Conway, 1995).

- Empty segments of the episode of experience under study, i.e. that cannot be recalled, are attributed by the authors (ibid, p. 151) to routine-based behaviours[178].

- Ericsson & Simon's (1984, pp. 150-151) account of the difficulties of full retrospective verbal reports may result from the researchers' inadequate probing (ibid, p. 150).

- Retrospective Verbal Reporting seeks generalisations through inferences (ibid, p. 151).

All coding schemes used in Protocol Analysis as described by Hoffman (2005) cannot be used in the present study :

- The *Abstraction-Decomposition* coding scheme is not applicable[179] to the study of the cognitive experience of a single subject. It rather depicts collaborative work and the variety of cognitive stances held by the different actors.

- The *Coding for Leverage Points* coding scheme seeks potential improvements of standard operating procedures (Hoffman, 2005, pp.70-72), which is not our goal.

- However, the *Coding an Unstructured Interview to Identify Rules for an Expert System* coding scheme seeks to elicit "*concepts and rules*" with a view to create inference-based expert systems, and the *Coding of Propositions for a Model of Knowledge* coding scheme (Hoffman, 2005, pp.69-70) seeks to formulate logical reasoning propositions[180], suggest that inference rules might be established in our research.

TAP/TAPS protocols yield elements of first-person cognition in line with the researcher's objective. It may be to elicit difficulties, information requirements, problem-solving

methods, recalls from memory (regulations or instructions for instance), … Operators can also be asked to express freely their thoughts as they come on their minds. These protocols are therefore "focused" and contained within the boundaries set by the researcher.

Verbal Reporting can also be assigned specific goals. They can be asked "*to retrospect about cases that they themselves encountered in the past*" (Hoffman, 2005, p. 65) as well as about a particular experience or a test case (ibid, p. 65). Verbal Reports are unguided recollections from episodic memory, the subject being "only" given instructions or asked questions as in Dekker (2002, p. 71) that frame his recollections. They do not exclude personal a posteriori re-interpretations and re-constructions.

6.1.3. The Human Factors Interview Protocol (HFIP)

Following their original suggestion to use head-mounted audio-video recorders (Omodei et al., 1997 ; Omodei et al., 2002), and based on the assumption that "*what remains relatively unclear are the mental (psychological) processes which generate safety-compromising orders and actions*", Omodei et al (2005) proposed the "*Human Factors Interview Protocol" (HFIP)*" at the Eighth International Wildland Fire Safety Summit held in Missoula, Montana, aimed at "*[revealing] the human factors causes of potentially unsafe decisions in the context of Australian wildland fires (i.e. bushfires).*"[181] (ibid). It targeted safety-critical situations.

Stressing "*the absence of an appropriate research methodology*" (ibid), they declared "*The scarcity of systematic research into the mental processes which underlie decision making in wildland firefighting […] not surprising given that such processes cannot be studied directly during the firefight*" (ibid), concluding that such mental processes ought to "*be studied retrospectively using interview techniques that cue memory recall.*" (ibid).

They described (ibid) "*Task-related psychological processes*" as ranging "*from basic interactions with the task environment via perception and attention, through the processes which comprise memory functioning, to the complex functions of reasoning and judgement.*".

HFIP's heuristic principle was "*to find out what is in and on someone's mind*" (ibid) and "*not to put things in someone's mind (for example the interviewer's preconceived categories for organizing the world)"* (ibid), in other words "*to access the perspective of the person being interviewed*" (ibid).

This would require "*To promote the recall of the maximum amount of relatively uncontaminated information, particularly in the early stages of the interview*" (ibid) and that "*the primary interviewing technique […] encourage the interviewee (i.e. the firefighter) to maintain during his or her recall an ownpoint-of-view or 'insider' recall perspective*" (ibid).

The protocol was staged in eight phases :

1. Setting the parameters

2. Eliciting the narrative and its chapters

3. Performing a collaborative analysis of the chapters

4. Stepping back - the wisdom of hindsight

5. Anything else?' – checking

6. Bigger picture

7. Even bigger picture

8. Wrapping up.

In Omodei et al.'s (2005) method :

- The focus is not so much on the subject's private cognitive experience, his "*mental experience*", than on his "*social experience*". The method elicits personal and collective attitudes and patterns of interactional behaviour, though, initially, the authors stated that "*The purpose of interviewing is to find out what is in and on someone's mind*" (ibid).

- First-person interviews[182] present risks : they may lead to a "*distorted understanding of the decision making process*" as "*experiences least likely to be recalled are those associated with actual or potential errors precisely because such experiences constitute a negative self-assessment*" (ibid).

- There is some emphasis placed upon collecting personal theories in stages 4 to 7. The progressive breakdown of the course of events into a *story* and its *episodes* frames the subject's account of his experience.

- HFIP targets commanders and tactical decision-making rather than field-responders and the cognitive control of their own performance in action.

6.1.4. In conclusion : the need for an ad hoc methodology

The methods used in NDM research cover a wide range of investigations. But, as seen in Omodei et al.'s (2005) proposal, the need for a first-person approach to cognition is advocated. Banbury et al. (2002) in their evaluative study of the Cognitive Model of Commercial Airline Threat Management (CAPT-M) also suggest that deterministic models of cognition do not reflect how people actually make decisions and explain that this may be due to the lack of introspective knowledge of the actual cognition of the subject, de facto calling for such an introspective analysis, hence a first-person methodology to investigate subjects' "private" cognition. And their conclusions make it clear that this cannot be achieved through the statistical study of numerous subjects but through the study of single cases.

6.2. The turn toward a first-person methodology

"*NDM studies seem to hinge on the study of unique events, situations that cannot easily be replicated. But this is not to say that the core phenomena cannot be replicated, which they are, across cases.*" (Maarten Schraagen et al., 2008, p. 10). The unique character of a subject's cognitive experience cannot be captured through statistical experimental methods (Allport, 1962). The investigation of the individual cognitive process that underlies the experience of trauma by one fire-fighter in the course of an intervention in the field presents this character of uniqueness.

Beside, the research context itself was constrained.

First, during our immersion in the field one fire-fighter, Lieutenant A, having experienced a CI and ready to participate in the research to perform guided recalls of his memories rather than delivering an embellished version of his story was identified. The study of his case could only be idiographic.

Secondly, this study performs a retrospective investigation of Lieutenant A's cognitive processes and of their patterns, of the cognitive operations he performed between the start and the end of his intervention. But there was no trace nor any recordings of his lived story. His episodic memory was therefore the only source of data available. Lieutenant A's experience dated back one month before the interview, and fortunately his memory proved to be still vivid. To minimise the risk of falling into the pits of the narration of biased social reconstructions and personal interpretations, a retrospective verbal protocol with proper episodic recall induction and guidance techniques (Vermersch, 2006) was needed.

An epistemological choice had to be made in response to our goals and constraints.

Radical empiricism is James' (1904, 1912) epistemological principle for the study of a subject's cognition. James (1904) opposes it to *rationalism* (the empirical science founded on statistics) that he sees as a science of the universal and therefore as an abstraction of the individual. Numbers fail to grab the subjective reality of a subject's experience of life, say Maarten Shraagen et al. (2008)… James' empiricism is the opposite of the "empiricism" usually referred to in positivist, quantitative methods (Bryman, 1984, p. 77). James (1904) also uses the term "*radical*" to say that *the researcher* must "*neither admit an element that is not directly experienced by the subject nor exclude an element that is directly experienced*" by the subject.

These elements are the *mental acts* and *mental objects* (Husserl, 1977), and their sequence, that form the subject's cognitive process :

- These acts, objects and temporal order are to be found in the subject's episodic memories of given, delimited, situated, embodied and enacted lived-experiences.

- Therefore, they are authentic if they are not the subject's life-stories, his retrospective generalisations, social reconstructions or philosophical re-interpretations of his lived experience. Nor are they the researcher's generalisations or theoretical interpretations of the cognitive experience.

To capture these authentic elementary elements of a subject's cognitive experience, this research relies on an idiographic study (Willig, 2008) and a first-person methodology[183].

6.3. First-person methods, their place in NDM and in cognitive science

First-person methods of research are meant for studying singular cases and are named (Creswell, 2007 ; Moustakas, 1994) phenomenological or (Vermersch, 2006) psychophenomenological methods. They search for a detailed description of "*reality through the eyes of participants*", the "*new naturalistic paradigm*" of psychological research (Henwood & Pidgeon, 1994).

A first-person case study starts with an interview of a subject about a given type of experience, which delivers a first-person narrative. From this material, researchers, who usually work in social sciences, extract categories through an interpretative open coding process. Categories are then clustered to bring about the sense of the subject's type of experience. Such approaches have been employed in disciplines on the edge of sociology such as gender studies to understand the *essence* of the experience of illness (Petitmengin, 2008), of the experience of deportation in nazi concentration camps (Barclay, 1995), etc.

Vermersch (2006) points to the necessity to study singular *episodes of experience*[184], away from life stories and generalisations, in order to collect data about *authentic* elements of cognition, *lived* as opposed to *reconstructed* or *interpreted* a posteriori, and for this to access the subject's episodic memory (EM). And to get such recollections from the subject's EM, the researcher needs an interview protocol that can trigger and focus recalls of the originally encoded elements of lived experience, while minimising the narration of interpretations, generalisations and reconstructions. These authentic cognitive operations may have been conscious or unnoticed (Varela & Shear, 1999a, p. 308 ; Vermersch, 2006) at the time of the actual facts. Conscious means that at the time of the actual facts, the subject was metacognitively aware of a given cognitive operation, for instance a thought or an emotion. Unnoticed means, on the opposite, that the subject did not have such an awareness. Unnoticed cognitive operations are called *pre-reflexive*[185], for not reflected upon in a metacognitive process.

In NDM research, Omodei et al. (1997, pp. 137-146) suggested the same move from third-person approaches (based on external observations) toward first-person accounts of the experience (from the own, "I", person's standpoint). They advocated the use of head-mounted audio-video recorders to get "*own-point-of-view stimulated recalls*" (ibid) of one's experience to video-cue "*the recall of other associated non-verbal components (e.g., affects, motivations, etc.)*". Omodei et al. (2002) add that the "*own-point-of-view*

psychological perspective […] of this procedure" allows "*to generate data not obtainable using other methods*" and "*to obtaining data on underlying psychological processes, especially those associated with error*.".

If there has been so far a great deal of "*blindness to the usefulness of working with first-person methods*" (Varela & Shear, 1999, pp. 11-12), research now needs to create a "*Necessary Circulation*" (ibid, pp. 2-3) between first-person and third-person studies.

Maarten Schraagen et al. (2008, pp. 10-13), while they present the epistemological differences between NDM research and experimental psychological science ("*Naturalism vs. Experimentalism*"), in response to criticisms of NDM, also advocate a necessary dialog between the two approaches, between statistical methods on one hand and case study and storytelling approaches on the other. In this sense, NDM research performs "*the initial steps of formulating questions and observing phenomena*" (Maarten Schraagen et al., 2008, p. 12) and feeds experimental science with new phenomena and questions (Henwood & Pidgeon, 1994).

The multiplication of scientific perspectives is beneficial to cognitive psychology : Newell's (1973) "*You can't play 20 questions with nature and win*" had highlighted the limits he saw to experimental psychology as it is based on the statistical study of dichotomies, *oppositions* such as peripheral vs. central. And he advocated computer simulation models to fit the growing mass of available data into a single coherent theory of cognition. Kosslyn (2006) answers Newell that these data are to be integrated within a *multi-level theory* of cognition, "*extraordinarily complex*" (p. 1522), founded upon three distinct levels of studies. First, the upper level of *computation* (what does cognition compute) is the level of a black-box experimental psychology. Secondly, the middle level of the *algorithm* (how does cognition work to compute) is the level of a white-box phenomenological psychology, typically as in NDM qualitative studies or in psychophenomenological studies. Thirdly, the lower level of the "*wetware*" (the brain's hardware that explains how the algorithm is computed) is the level of brain sciences, neurophysiology, brain imagery…

Already, such an integration is part of hard sciences and, for instance, "*contemporary neuroscience allows subjective report to be part of its methodology*" (den Boer, 2008, p. 380), introspective data[186] being used today "*in four different ways*" (pp. 382-383) :

	Guided introspection	Unguided introspection
Weak introspection	participants are asked to pay attention to perceiving stimulus, a procedure which is usual	
Strong introspection	participants are specifically instructed to pay attention introspectively to what feelings are evoked by presentation of a sensory, visual, or auditory stimulus	the participant is asked to pay attention to what he is currently experiencing without special relationship to an ongoing stimulus
Neurophenomenology		Same as strong introspection but without any relationship to an ongoing stimulus presentation; aiming at invariant self-organising structure of experience

Table 11 The use of introspective data in neuroscientific investigations

Thus, neurosciences study both "*the immediate feltness of a feeling, and its perception by a subsequent reflective act*" (James, 1890, p. 189) and seek to bridge the gap between cognition and brain processes.

6.4. Conclusion : A summary of methodological requirements

First, we must take great care of the subjects, in line with the prescriptions of the British Psychological Society, as we are dealing with a human subject and evoking the experience of trauma may trigger noxious feelings and reactions in him.

From what precedes, we assume that our research method should also have the following characteristics :

Required characteristics	Opposite characteristics
1) The focus of data collection is on an individual's cognition during a given, delimited, situated, embodied and enacted episode of experience.	The focus is on populations, or narratives of whole-life experiences, of a "kind" of experiences (several ones), or on social interactions in a context of action…
2) Data collection aims at producing a first-person narrative of such an experience.	The protocol uses observations, think-aloud protocols, third-person accounts by witnesses, interviews of several participants in the event, group debriefings, category-based questionnaires, expert's judgement…
3) The subject's interview protocol must help him to perform recalls of his authentic (= not interpreted, not reconstructed, not theorised) episodic memories of the episode of experience. The researcher must not censor the subject's narration but only induce and guide recollections from episodic memory : any recollection is welcome as long as it has to do with the subject's authentic cognitive experience of the episode under study, not with retrospective judgements and generalisations.	Interviews allow the subject to narrate his personal theories or social reconstructions or an a posteriori reconstruction of the episode of experience.
4) The processing of the narrative must allow to elicit cognitive operations performed by the subject during his experience through a semantic open-coding	Interviews based on questionnaires are processed so as to elicit or to analyse pre-defined categories of different levels of abstraction or of decomposition ;

process ; refinement of the categories may occur through iterations between coded categories and the semantic analysis of the narrative as natural language takes a variety of forms to express a single concept (Watson, 2006).	automatic text analysis software may be used to dig out words defined in a dictionary.
5) As far as possible, data processing should prepare both for a purely qualitative, interpretative analysis, and for an exploratory factor analysis of the data extracted from the first-person narrative. Data analysis should rely as needed upon interactions between the two.	Data analysis is quantitative only.

Table 12 Methodological requirements for the research

The next chapter presents the psycho-phenomenological foundations and general modalities of a first-person methodology.

CHAPTER 7. Phenomenological Psychology and its methodology

Phenomenological Psychology seeks to study an individual's experience of life from his inner, private, subjective standpoint. In this thesis, we assume an equivalence between the words "consciousness" and "cognition", between "mental" and "cognitive", between "subjective" and "cognitive". This view is supported by Husserl (1977, p. 148, pp153-157), Thompson (2007, p. 17), Dilthey (1977), Rouger (1969), Gusdorf (1951), Bachelard (1934), and by Marbach (1993) in particular who explains that "*cognitive psychology and related philosophy of mind*", i.e. phenomenological psychology, share "*their objects – i.e. mental phenomena – a systematic descriptive analysis of consciousness*". In this chapter, we recapitulate the fundamental assumptions of phenomenological psychology and present two methods that provide the foundations of our methodological apparatus, psychophenomenology for data collection, and phenomenography for data processing.

7.1. History and principles of Phenomenological Psychology

Phenomenology at large is the sum of three main currents of studies. First, *Transcendental Phenomenology* roughly postulates that things are not (just) what they are but what our relation to them makes them. It is interested[187] in getting to the *essence* of things present in our world of activity through the *variation* of an individual's subjective experience of them, which "*allows us to view the world, not as a pre-given reality, but rather as constituted by consciousness*" (Naudin et al., 1999). This branch of phenomenology is not the one we are interested in for this research. Secondly, *Existential Phenomenology*, or existentialism, is interested in the conditions of our freedom and free-will [Heidegger and Sartre are among the major philosophers in this branch of Phenomenology.]. This branch of phenomenology is also not the one we are interested in for this research. Third, *Phenomenological Psychology* is interested in our "*pure subjectivity*" i.e. in our inner experience of the world, with *our cognitive experience of* the world and, through the creation of sense that each cognitive act allows, in the progressive constitution of one's Self, one's identity and personality. In other words, it seeks to study the subjective experience of encounters with things and events at hand, the memories of these subjective (personal, private) experiences, and the compilation of these experiences into a life-history and the constitution of the Self.

The history of Phenomenological Psychology saw it marginalised. Born with Brentano (1874), Phenomenological Psychology and the also newly born Scientific Psychology,

founded by Wundt[188] worked hand in hand for some time (den Boer, 2008). Unfortunately, several factors[189] contributed to marginalise the former and to leave the floor to Experimental Psychology and, later on, to Behaviourism (Thines, 1977, p. 56). The new "*psychophysical, physiological, experimental*" psychology, born in the nineteenth century[190], "*advanced so far as to make its psychological knowledge practically useful, just like physical and chemical knowledge*" (Husserl, 1977, p. 3). As it could not match this performance, Phenomenological Psychology fainted away (Husserl, 1977, p. 1). But, as Husserl also reminds (1977, pp. 3-7), an early radical criticism marked scientific experimental psychology, and a first revival of the idea of Phenomenological Psychology came about in 1894 when Dilthey published his "*Ideen über eine beschreibende und zergliedernde Psychologie*" in the Sitzungsberichten der Berliner Akadamie. Dilthey, Husserl (1977) says, called for a "*descriptive and analytic*" psychology that would turn toward "*internal experience*"[191], this task concerning the complex interaction of our mental acts[192]. Ryle (1949) and Skinner (1985) definitively forbade psychology to consider as scientific what is going on within one's mind. Phenomenological Psychology was nearly ignored until 1975, Marbach (1993, p. 14) says, when *consciousness* became again an acceptable topic in psychology. The real "*revival of interest for phenomenal consciousness*" took place by the end of the eighties (Gallagher & Zahavi, 2007, p. 4). First, it demarcated itself from the old *introspectionist* temptation of early phenomenological psychology. Then, in the nineties, the objections to cartesian dualism (Damasio, 1994/2006) along with the emergence of Neurosciences raised the question of the embodied cognition and contributed to undermine the classic *computer-like* approach to cognition (Gallagher & Zahavi, 2007, pp. 4-5).

Phenomenological psychology was conceived of as an "*Act Psychology*" (Thinès, 1977, p. 56), in the sense of a "*science of the disclosure of pure internality*" by Husserl (1977, p. 148). It sought to study our "*consciousness*" understood as the rolling flow of mental operations performed by an individual. Three elementary concepts are at its very root :

- "*Phenomena*", subjectively "*experienced facts*" (Thompson, 2007, p. 61), such as "*affect, motivation, attention, habit*" (Thompson, 2007, p. 17), are the central element of the experience of life by a given individual (Keen, 1975, p. 139).

- Phenomena are pairs[193] of {*mental act* ; *mental object*}[194]. They can be assimilated to cognitive operations.

- A "*mental act*" relates to, i.e. "*intends*" to a mental "*object*" in a necessary and unbreakable relation. This "*basic feature was called intentionality*" (Thompson, 2007)[195].

The "Actus" (Husserl, 1977, p. 160) is the "*connective force in the mind that links impressions and ideas in virtue of their simultaneous occurrence, proximity, or repeated succession*" (Thompson, 2007, p. 31). We can understand *actus* as the sensemaking property of a series of cognitive operations, successive pairs of {cognitive act ; cognitive object} forming the cognitive process of Decision-Making-in-Action (DMA).

Varela (1999) stresses that *affects* are "*sculpting the dynamical landscape*" of this cognitive process, possibly "*emotional traces from past experiences*" (Banakou et al., 2013). Affects are characterised by Thompson (2007) as :

- "Emotion", an "*outward movement [that is] the welling up of an impulse within that tends toward outward expression and action*" (Thompson, 2007, pp. 363-364), in other words "*a response to relational meaning […] a person's sense of the harms and benefits in a particular person-environment relationship*" (Lazarus, 1993b), the "*awareness of a tonal shift*" (Varela, 1999, p. 132), an experiential shock resulting from an object's "*affective allure*" that acts as an attractor of consciousness toward new unexpectable directions (Thompson, 2007, chapter 9).

- "Affect" : *Affect* must be understood here as "*a dispositional trend proper to a coherent sequence of embodied actions*" (Thompson, 2007). To clarify this notion, we can understand it as a binary "like / dislike", "attraction / repulsion" feeling.

- "Mood" "*a background setting*" that "*favour particular emotions and interpretations […]*" (Thompson, 2007, pp. 378-379).

"Affection" is to be understood as the *impact* on consciousness of what emerges in consciousness (Thompson, 2007, pp. 371-381). Its associated concepts is the "*Affective Tone*", or "*Affective Allure*", or "*Affective Force*" of the phenomenon at hand. The affective allure of a phenomenon contributes to the *transition* toward the next mental operation and can be seen as a notion close to James' (1950, Volume 1, p. 258) concept of "*fringe*" : the "*influence of a faint brain-process upon our thought, as it makes it aware of*

relations and objects but dimly perceived" due to the "*part of the object cognized, substantive qualities and things appearing to the mind in the fringe of relations.*".

The "History of the I" (Husserl, 1977, p. 161), or I-History, is shaped by the successive "*comprehensions of the world that persist for the subject*" that also create "*habitualities*"[196]. The sum of these habitualities constitutes one's personality (I-Personality) and attitudes.

The "Life-world" is our "*everyday-world in which we live […] and the things that can be directly experienced within [it]"* (Thompson, 2007, p. 34), which one can conceive of as an "*openly infinite multiplicity*" (Husserl, 1977, p.57). The successive constitutions of one's life-world make-up his I-World as accumulated knowledge of one's life-world. Thompson (2007, p. 34) says that the life-world, being imposed upon us ("*always a pre-given*"), serves as "*the horizon of all our activities*".

The "Horizons" that our various life-worlds (Schutz, 1987) set, select "*the things of which we can experience*" (Thompson, 2007, p. 35).

Experience has a temporal dimension, the transitional "retention-protention" dialogue between past experiences and the open landscape of the future, anticipations of all forms.

The "Present Moment" (Stern, 2004 ; Gusdorf, 1951 ; Bachelard, 1934) is the unit of the subjective experience, a "*living present*" (Schutz, 1987 ; Keen, 1975 ; Thompson, 2007 ; Marbach, 1993 ; Varela, 1999). The Present Moment is a *kairos*[197], a "*passing moment in which something happens*" (Stern, ibid, pp5-7).

7.2. The episode of experience as research object

This research is based on a fundamental epistemological assumption.

We assume its object is a given "*episode of experience*", i.e. a given, delimited, situated, embodied and enacted episode of action. Within an episode of experience, the "*Present Moment*" (PM) is the smallest sensemaking unit of experience remembered and narrated by a subject. In the narration of a PM, the subject relates a transformation of circumstances or of his own relation to circumstances.

A PM can only loosely be assimilated to a decision-making cycle. A PM is potentially made of a number of "*decision-making cycles*". Theoretically, decision-making cycles are the smallest portion of cognitive process that spans between an initial cognitive stimulus and the corresponding response of the subject, an action in the physical world. The longer the PM's duration, the more decision cycles are likely to be performed by the subject. When short, a few seconds for Stern (2004) for instance, PM and decision cycle are one same cognitive process.

The narration of a PM may omit some, possibly many, decision cycles, for instance when the PM is not a memorable experience of a neutral valence (Gusdorf, 1951), or not interesting or acceptable to narrate (Watson, 2006 ; Gardner, 2001) from the subject's social stance.

Therefore, the recall and narration of elementary decision cycles being uncertain during interviews, this leaves the qualitative researcher with narratives of larger-than-decision-cycles stretches of cognitive processes, i.e. Present Moments.

Like elementary decision cycles, Lieutenant A's narrative shows that PMs are demarcated by a triggering cognitive stimulus as their beginning, and a resulting action, or series of actions, as their end.

The present research seeks to analyse the pattern of the cognitive process of each PM and the general cognitive pattern of the entire episode of experience.

7.3. The Present Moment (PM) and associated epistemological assumptions

7.3.1. The Present Moment as sensemaking narrated unit of experience

Daniel Stern is a Medical Doctor and Professor of Psychiatry at the Cornell Medical School. Like Guitton (1988), Stern's (2004, p. XI) therapeutic practice focuses on "*small elementary events that make up our worlds of experience*".

The Present Moment (PM) is the "*process unit for [such] experiences*" (Stern, 2004, p. 20). It is the smallest segment of the "*actual experience, a subjectively lived happening […] lived with feelings and actions taking place in real time, in the real world, with real people*" (ibid) that the subject can narrate. It is (Stern, 2004, pp. 31-40) the "*felt experience of what happens during a short stretch of consciousness*".

PMs have sense for the subject because they each have a "*trigger*": "*something must happen to bring them to psychological life*" (ibid, p. 56), they each are "*structured around a plot*" (p. 57), and they each "*have a line of dramatic tension*" (p. 57).

7.3.2. Duration of a PM

The objective length of a PM can vary from a "*short duration*" of some seconds (ibid) to several minutes. A victim rescue intervention at the BSPP lasts 40 to 60 minutes for instance and this episode of experience is made of several PMs, the length of which should range from several seconds to several minutes.

From a subjective perspective, Bergson (1934) says it is vague ("*flottant*", floating), "*related to the attention we pay to our life*", the Present Moment "*taking just as much space as that effort of attention*". For Gusdorf (1951, p. 18) "*The objective duration of the Present Moment varies to a considerable extent, but, beyond doubt, it can last for a considerable period of time : we can say 'now' of the entire hour we spend in the dentist's chair or of the whole morning spent to solve a baffling problem*" (p. 11) : "*The consciousness of time bears on what fills-up this time and not on the abstract framework of its duration*" (p. 13). The "*unit*" that measures time in our awareness of the Present Moment is "*the unit of the drama or of the adventure I am currently experiencing*" (p. 42[198]).

7.3.3. PM, valence and faculty to be remembered

The Present Moment can be understood "*as the consciousness of […] a concrete situation*." (Gusdorf, 1951). "*Concrete*", as in "*concrete memory*" ("mémoire concrète") is the key characterisation of the Present Moment for Gusdorf (1951, pp. 76-80), and each moment of our experience can be remembered in two distinct ways : an abstract and a concrete one.

<u>Abstraction</u> lies in the fact that once the Present Moment is gone we retain its meaning (p. 77). This abstract memory is "*deprived of any reference to the authentic time that we experienced*" (ibid[199]). Our "*abstract memory*" is "*what is left when we forgot everything, a memory that transcends reality*" (p. 79[200]).

Our <u>concrete</u> memories, on the opposite, seem "*useless, intervening only by chance in our present experience, always surprising us*" (ibid[201]). They would be "*expanding, a memory of luxury and magnificence, a historical self-awareness revealing the plenitude of what I*

was once" (pp. 78-79[202]). The memorised "*pieces*" (p. 79) of a past Present Moment (pp. 69-76) "*revive, often in an unexpected fashion, such or such past moment in the plenitude of its original taste*" (p. 76[203]) and "*may be useful in the construction of new Present Moments*" (p. 79[204]).

"*Abstract Memory*" refers to the *autobiographical knowledge* derived from experience.

"*Concrete Memory*" is the *episodic memory* of the flow of a given episode of experience, with its texture and details.

Gusdorf (1951, p. 29, p. 40) says meaningless or "*uninteresting*" moments may seem very long while very little remembered, and very meaningful or intense (p. 37) moments can be very short but vividly memorised. Unremembered Present Moments are those which did not engage us because the perspective they bore was annoying, mediocre, or even worthless to us (p. 34).

The Present Moments we memorise in our *concrete* memory are those that have a valence, an "*affective value*" (Gusdorf, 1951, p. 35). The affective quality of a Present Moment is what will make it more or less easy to recall. It is the resonance of the situation with the subject's history, his "*Total Present*" (Gusdorf, 1951). A historical moment, says Gusdorf (1951, p. 37), is one of a decisive importance, one that reshapes my Total Present. A Critical Incident is such a historical moment. It is a high affective valence Present Moment. It is a shock, that "*questions me in the immediate violence of the situation, that leaves me incapable to analyse what is going on, that I feel directly as the death of life values, a surprising image only commented by the shock in me, felt as a whole, and subsisting in me as a whole, which I later retrieve in me as a whole with its emotional power*" (ibid[205]).

7.3.4. Demarcating Present Moments

It is posited in the present study that Present Moments will be demarcated by :

- An **initial context**, preceding the start of the Present Moment : by convention an "*action*", the one the subject last performed, or a "*state*" (of "*being in the world*" : the subject stands in his world of life, in a state of idleness or in waiting)[206].

- A **trigger** : the beginning of a Present Moment will be the *acquisition* of a fact constituting an initial cognitive stimulus, a situation at hand.

- A **cognitive trajectory**, or cognitive process, made up of a sequence of various *cognitive operations* sparked one after another and creating a tension toward a *decision* or *urge* to act upon the initial cognitive stimulus[207].

- A **conclusion**, a new ad hoc *action* or *state* marking the end of the PM's plot.

7.4. The methods of Phenomenological Psychology

Our first endeavour was to establish a method that would allow the collection and the analysis of a given, delimited, situated, embodied, enacted episode of experience and its PMs.

7.4.1. Psychophenomenology as data collection method

Phenomenological Psychology has had the ambition to be a science of consciousness but it never produced a widely adopted working methodology. One could argue that cognitive psychology is such a methodology. Psychophenomenology is the methodology that materialises this ambition.

Psycho-phenomenology, Maurel (2008) says in Expliciter[208], is a "*branch of psychology the aims of which are to develop a method to access the subject's subjective experience and to develop the descriptive categories and conceptual definitions necessary for this description*"[209]. It is a regular reference in neuroscience (Varela, 1999, den Boer, 2008).

Research in Psycho-Phenomenology started in the mid eighties when Pierre Vermersch (2006, p. 173), in the animation of error analysis workshops in the fields of Education and Work Psychology, felt the need to help other researchers to study how teachers and students in class were dealing intellectually with problems at hand.

The "*Elicitation Interview*" (EI) is the practical method to access the subjects' episodic memories of a given, delimited, situated, embodied and enacted episode of experience in order to elicit his authentic cognition of the time. Vermersch (2006) assigned it three goals :

1. To help the interviewer to get information on how the interviewee performs a specific task in order to find out which difficulties he faces and how he deals with them, the possible causes of his erroneous or unsuccessful behaviours, or on the opposite the factors that lead to success, or else to understand the cognitive process involved in the

performance of the task, i.e. the aims the individual sets, the reasoning he does, the knowledge he mobilises, the way he represents the situation, … (p. 18)[210].

2. To help the interviewee to inform himself : expliciting one's own inner cognitions helps an individual to raise his awareness of how he processes tasks at hand (Vermersch,2006, pp. 27-29). It is a pedagogy "*based on a reflexive going back to one's experience*"[211] (ibid) that "*helps the learner to reflect on his own ways of thinking*"[212].

3. To teach the interviewee how to inform himself about "*how he knows he performs a specific act*" : learning metacognitive skills that can be mobilised in action to help the subject to better control his own cognition and, by way of consequence, his action (ibid, p29)[213].

The principle of the Elicitation Interview is to obtain from the subject a "*re-presentification*" (Vermersch, 2006, p. 57), i.e. a controlled cognitive *re-experiencing*, of a past, given, delimited, situated, embodied and enacted episode of action.

Being guided (second-person interview technique) to recall episodic memories of this episode, the subject can narrate it (into a first-person narrative = on the "I…" mode) in great details as his memory is rich of conscious and pre-conscious cognitive operations and actions performed at the time of action.

The EI *directs the subject's attention* to his authentic cognition and action of the time, and avoids his a posteriori reconstructions, interpretations and generalisations (Vermersch, 1999). For the researcher to detect these elements "*that stand there in front of us [and that] can be unveiled only if one has the idea to look for them*"[214], Vermersch (2006, pp. 43-52) has synthesised from research a taxonomy[215] of the elements that can be recalled from episodic memory. They are categories of the subject's actions, cognitions and "*peripheral data*"[216] (ibid, p. 43) :

Procedural data (*Doing*) :
• Elementary actions performed
• Mental operations performed
• Practical know-how used
Contextual data (Externalities) :
• Circumstances encountered
• Environment
Judgmental data (Metaposition[217]) :
• Subjective evaluations of one's experience

• Beliefs about one's actions and cognitions
Declarative data (Knowledge) :
• Theoretical knowledge mobilised
• Procedural instructions
• Regulatory instructions
Intentional data (Goals & Motives) :
• Goals or (temporary) sub-goals pursued
• *De facto, circumstantial ad hoc* intentions or motives

Table 13 Vermersch's (2006) taxonomy of typical phenomenological recollections

Some comments should be added :

- Sensations, sensori-motor data, are not mentioned by Vermersch as they were not part of his domain of research, education. They are body-related contextual data.

- Emotions are merely considered by him as part of the textural data : "*some [authors] also include emotional tone as a descriptive element attached to action*" (Vermersch, 2006, p. 202), maybe again as his research was centred mainly on education in the classroom.

- Practical know-how, routines, is included by Vermersch into procedural data.

- Intentional data do not include a specific form of motivation (as "*Driving force or forces responsible for the initiation, persistence, direction, and vigour of goal-directed behaviour. It includes the biological drives such as hunger, thirst, sex, and self-preservation, and also social forms of motivation such as need for achievement and need for affiliation*." (Colman, 2006, p. 479)).

- What Vermersch refers to when he uses the term *evaluation* can be an *a posteriori*, post-action global subjective judgement of one's handling one's action (Vermersch, 2006, p. 47). If Vermersch attracts our attention to this kind of autobiographical elements, it is because subjects may insert in their narrative retrospective judgements that do not pertain in the actual experience itself and they must be avoided. But judgements are also made as the course of action progresses : they are thoughts, a reflection upon the meaning and sense of the experience in progress. The researcher must not mix them up.

- With regard to our focus on the cognitive processing of the experience, in the course of his action a subject may become aware of his own cognitive processing of the situation at hand. *Metacognitions* are a sub-category of procedural data.

- "*Knowledge*" should be understood as knowledge of the facts of the world and of our body. One's attitudes towards life, people, objects and issues, sense of life, and assumptions about the world are likely to be recalled by the subject as part of his past experience.

During the interview or during its analysis, this taxonomy helps the interviewer to segregate authentic, episode-specific phenomenological recollections from *a posteriori* reconstructions and theorisations of the subject's experience (Vermersch, 2006, p. 45). It helps :

- To draw the researcher's attention to the "*parasites*" of phenomenal narration, the *judgmental data* that are often included within the narrative, as the subject reflects retrospectively on his experience, elements of his *metamemory* (Brewer, 1995), retrospective "*beliefs about the operation of their own mental processes*" formed after the events, and of which Vermersch (2006, p. 47) provides examples : "*it didn't work… I didn't do much…it was difficult… I'm not very pleased with myself, etc…*".

- To cue recalls from subjects' autobiographical memory as the taxonomy shows the diverse paths the researcher can take to help the subject to reconnect with a given episode of his past experience.

In summary, the EI appears as a method that rigorously helps the researcher to focus the subject's attention on the authentic elements of his cognitive experience at the time of the episode of action he narrates. The EI does not allow free narrations and seeks to avoid social and narrative biases : retrospective interpretations, generalisations and reconstructions of the authentic cognitive experience. Thus, the first-person narrative so produced should allow to unveil the cognitive operations and processes of Decision-Making-in-Action, nothing else, in a *radically empiricist* (James, 1904) epistemological stance.

Once these data collected, what can the researcher do with them ?

7.4.2. Phenomenography as a formal description of the cognitive experience

In traditional phenomenological psychology as well as with psychophenomenology, narratives are usually freely analysed through open coding, clustering and interpretation (Creswell, 2007 ; Moustakas, 1994).

Phenomenography is the idea of a formal modelling or description of the cognitive experience related in a first-person narrative.

For Marbach (1993, p. 9) a "*phenomenography*" of the cognitive objects of experience is a "*conceptual notation or ideograph)*", which he deems "*indispensable […] in a domain where even the phenomena to be studied scientifically are elusive, as it is the case with mental activities*".

Marbach (1993, p 7) explains that "*in order to convey a truly scientific content to the terms/concepts that cognitive psychology and related philosophy of mind use for determining their objects – i.e. mental phenomena – a systematic descriptive analysis of consciousness in its own nature must be presupposed*".

For this purpose, he posits that a "*language of phenomenology*" conceived as "*an intersubjectively available tool*", a formal "*notation*", a "*precise language*"[218], should be introduced for the purpose of "*communicating phenomenological results*". Through such a formal notation, mental phenomena could be described, both in their static and dynamic structures[219]. Mental Operations were rendered in Marbach's phenomenological notation (Marbach, 1993, pp. 25-40) in an algebraic form. One of the simplest examples Marbach (1993, pp. 25-26) provides is :

$$(REP - \frac{[PER]x}{(PER)y})x$$

This strange and unconventional notation describes a cognitive operation (Marbach, 1993) :

- a recall (REP) of object "x" as it was perceived = $[PER]_x$ while perceiving object y = $(PER)_y$,
- "REP" = Representing, recalling (a cognitive act made upon what follows the "–"),

- “PER” = Perceiving (this is a cognitive act),
- “x” and “y” = cognitive objects involved in the cognitive acts,
- “()” or “[]” demarcating the terms of the cognitive operation.

Other examples are provided by Marbach (1993) describe more complicated cognitive operations and become more complicated to interpret. No practical application of this notation could be found.

In this research, provided both static and dynamic dimensions be taken into account, we define a phenomenography as the data processing stage of the formal description and modelling of an episode of cognitive experience.

7.5. The structure of the episode of cognitive experience

From what precedes we can derive a general model of the cognitive experience of a singular episode of action narrated by a subject in an Elicitation Interview :

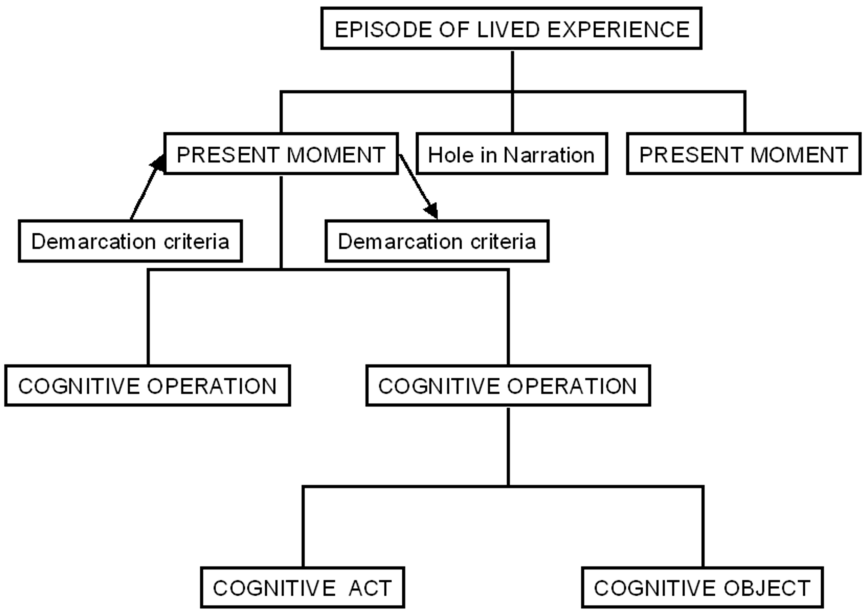


Figure 10 The general model of the cognitive experience

An *episode of lived experience* a subject narrates has two main components : *Present Moments* (PM), and *holes*, i.e. PMs not remembered or not narrated by the subject.

Present Moments are *demarcated* by criteria such as the initial perception of a change in the scene (Stern, 2004, p. 14) and a final action. Present Moments are decomposed into a sequence of *cognitive operations*.

Cognitive operations are posited to be performed in sequence : neurosciences suggest that a cognitive operation corresponds in the brain to a *global mental state*, a *large-scale global synthesis* (Varela, 1999 ; Lutz et al., 2002 ; Dehaene et al., 2006 ; Naccache, 2006). Global syntheses occur in sequence[220], each one lasting between 250 millisecond and several seconds.

At the time of the actual lived experience, cognitive operations may have been (Vermersch, 2006 ; Dehaene et al., 2006) either *conscious* i.e. either *reflexive* (= as we perform them we are fully aware of them), or *pre-reflexive* (or pre-conscious = as we perform them we are not aware of them). Conscious and pre-conscious cognitive operations are encoded into episodic memory (Damasio, 1994, p142 ; Conway, 2004) and can be recalled and narrated during an EI.

A *Cognitive Operation* is an undissociable pair of {Cognitive Act ; Cognitive Object}(Husserl, 1977 ; Rouger, 1969 ; Thinès, 1977 ; Thompson, 2007). *Cognitive Acts* are functions that, applied to *Cognitive Objects*, produce the meaning (Varela, 1999, pp. 134-137 ; Dehaene, 2006) that makes the cognitive process in progress move on. Cognitive acts belong in various types and include "*impressions, sense feelings, perceptions, memories, expectations, multiple types of judicative knowing, valuing, desiring, willing*" (Husserl, 1977, p. 11). Cognitive objects also belong in various types : self, others, objects, ideas, plans, and more generally any focus of the attention of one's consciousness.

In the light of the elements gained through this first part of the study, the next chapter details the research question exposed in the abstract of this report.

7.6. Conclusion : Refining the research question

We can now summarise the assumptions entailed by the research question presented in the conclusion of chapter 3 and situate it within the entire problem space developed earlier.

7.6.1. Summary of the argument (the problem space)

For fire-fighters, experiencing Critical Incidents (CI) during interventions in the field is common, and the more so as they are under regular attacks from human beings, or even from dangerous dogs. CIs are of a traumatic nature. One essential characteristics of trauma exposure is peritraumatic dissociation. The exposure to trauma is said to be capable to affect people's capacity to perform. But real life cases heard of at the BSPP or read in Critical Incident reports show that fire-fighters usually manage to resume and complete their mission after the exposure[221], as in the case of Lieutenant A. This aptitude of the subject to surmount traumatism at the time of exposure is called Peritraumatic resilience (PTR). We assume it is the outcome of DMA (Decision-Making-in-Action). DMA is the cognitive process that controls a subject's performance during a given, delimited, situated, embodied and enacted episode of action. Under the circumstances of a CI, this process is assumed to yield three coping capabilities essential to PTR : getting-by, resisting, and resuming. And if it does so, it is possibly because DMA includes ad hoc metacognitive processes. To capture these personal cognitive and metacognitive processes after the events in the absence of traces and video records, a first-person methodology is required to access the subject's episodic memory and to allow him to recall the authentic elements of his cognition and action of the time of his actual experience rather than his retrospective social and theoretical reconstructions, reinterpretations and generalisations of the events. Such a methodology is based upon epistemological assumptions inherited from psychophenomenology, which can be itself considered as a particular form of retrospective verbal protocol.

7.6.2. Hypothesis

Within the cognitive process of DMA, peritraumatic resilience might result from metacognitive processes yielding the required ad hoc coping capabilities (getting-by, resisting, resuming).

7.6.3. The object of the research

The *episode of experience* is the fundamental object of the research. We posit, along with phenomenological psychology, that the *Present Moment* (PM) is the subject's unit of narration of his lived experience. PMs are made of a sequence of *cognitive operations* (CogOp) forming the cognitive process that fires a response (an action) of the subject to an initial cognitive stimulus.

7.6.4. The objectives of the research

This research is an investigation into the cognitive processes of DMA that underlie Lieutenant A's peritraumatic experience of a Critical Incident (CI) during a victim rescue intervention. During this intervention, he is exposed to an attack from two rottweiler dogs and is subsequently caught in the middle of the heavy gun shooting by police officers attempting to kill the animals.

The present research seeks to analyse the cognitive pattern of Lieutenant A's episode of experience and of the cognitive process of each Present Moment that compose it, and to explicit how peritraumatic resilience is yielded in this context.

To this end, it aims at :

- Elaborating the methodological framework allowing to perform the study of Lieutenant A's case within the frame of the various constraints and hypotheses expressed in Part 1.

- Showing if the Elicitation Interview protocol can trigger and guide the subject's recall of authentic (not reconstructed) cognitive elements from his episodic memory.

- Modelling the subject's cognitive activity in a manner that elicits cognitive operations (CogOp) and reveals cognitive trajectories, i.e. patterned sequences of CogOps.

- Studying the link between DMA and PTR as it is posited that the latter stems from metacognitive processes within the former.

- Using the associated cognitive models and findings to elaborate a metacognitive training framework aimed at preparing fire-fighters (and other people working in high risk environments) for the peritraumatic experience of potential CIs.

7.6.5. The limits of the research

There are two essential limits to the present research :

1. We perform an idiographic case study, with its inherent limitations and its methodological differences with positivist, statistical research.

2. The validity of the study relies upon the accuracy and authenticity of the subject's episodic memory recalls.

As we shall see, the Elicitation Interview (EI) allows the subject to recall a great number of actions and cognitive operations he performed at the time of the actual episode. But we cannot be guaranteed that he recalls all of them, that he does not hide some of them, and even that he does not discretely reconstructs some of them. These are limits one must keep in mind, and they justify the precautions taken along this research in order to avoid these biases as far as feasible.

As for the idiographic character of the study, we shall see that the significant number of cognitive operations and actions (all called CogOps to simplify our discourse) stimulates a quantitative analysis of data gained from the case. Here again lies one limitation, inherent to the nature and context of the production of those data. Distributions are not normal and ad hoc quantitative methods have been adopted.

With these elements in mind, the next part of the report presents the methodological framework created for the present study and later similar research.

Part 2. THE RESEARCH DESIGN

CHAPTER 8. The research method : Pheno-Cognitive Analysis (PCA)

Part 2 describes in detail the Pheno-Cognitive Analysis methodological framework created for the present research. This framework has been the object of progressive refinements and has concentrated much of the effort spent on the latter in order to facilitate data analysis. First, this chapter, following the recommendations of Creswell (2007), Silverman (2006), Willig (2008), presents the epistemological foundations and an overview of the PCA framework. Secondly, later chapters of Part 2 detail its successive phases, and elements of *memoing* (Creswell, 2007) help the reader to trace the steps taken in its creation.

8.1. Assumptions constitutive of the PCA framework

The assumptions that frame the PCA framework are :

- A *research object* : An individual's given, delimited, situated, embodied and enacted episode of cognitive experience, performed in the field, in natural settings not in laboratory conditions, during which a Critical Incident occurs. The case is that of Lieutenant A.

- A *conceptual framework* :

    - *Ontological* : The research aims at describing and studying the structure, processes, variations and other characteristics of the research object.

    - *Epistemological* : The research is radically empirical and seeks to collect data depicting a subject's authentic cognitive experience of a Critical Incident (CI) during a specific victim rescue intervention, away from his general theories and social reconstructions of such circumstances.

    - *Axiological* : The goals of the research are to investigate the cognitive processes of Decision Making in Action (DMA) that underlie Lieutenant A's peritraumatic experience of a Critical Incident (CI) during a victim rescue intervention, and to show whether or not it is possible to study retrospectively, out of his Episodic

Memory, the subject's cognitive experience of this given episode of experience, here including a Critical Incident.

- *Methodological* : The study of the subject's cognition is performed on the basis of a guided recall of the subject's authentic episodic memories of the particular episode of concern to this research. Authentic means recalling and narrating the actions and cognitive operations actually performed by the subject at the time of events.

- A *research paradigm*, i.e. a scientific approach to data collection, processing and analysis that entails its own questions and methods. In the present case, a psycho-phenomenological "white box" approach to the cognitive processes that control a subject's performance.

- An *interpretative framework*, a particular "lens" through which to make sense of results during the discussion. Metacognition, and in particular metacognitive training, is the perspective chosen in this research.

- A *methodological ambition* to design and describe an effective, consistent PCA framework, and to contribute NDM research through the cognitive study of individual decision-making in action, of the experience of trauma in action, and of peritraumatic resilience.

8.2. Overall presentation of the PCA process

The process of a Pheno-Cognitive Analysis comprises the following phases :

- *Data collection* : Chapter 9 details the principles of the Elicitation Interview (EI) used to allow the subject to recall his authentic episodic memories of the episode under study, and provides precise guidelines for its conduct and for the transcription of the narrative. This chapter also presents the basic principles of the immersion in the field that may be (and was in the present study) run before performing EIs.

- *Data processing* : Chapter 10 presents the origins, principles and guidelines for the semantic parsing of the narrative into speech clauses, their chronological resequencing into a chronotext, the elicitation of cognitive operations (CogOp)[222] and the elaboration of a taxonomy of their constituting cognitive acts (CogAct) and cognitive objects (CogObj), and the elaboration of the basic cognitive model of the subject's experience,

the cognigraph. It also provides guidelines for the production of the Decision Networks, derived from the cognigraph, that reveal the statistical patterns of DMA.

- *Data analysis, discussion and conclusion* : Chapter 11 recapitulates the guidelines learned from the research in relation to :

  - The interpretation of Decision Networks and the analysis of DMA[223] patterns.

  - The categorical analysis of the inter-variation of DMA patterns, as successive PMs are likely to have cognitive trajectories of different patterns.

  - The Exploratory Factors Analysis intended to search the factors of the intra-variation of DMA patterns, as each DMA pattern is likely to take a variety of shapes.

  - The categorical and qualitative analyses of peritraumatic resilience (PTR) and its factors.

  - The elaboration of models of DMA and PTR that synthesise Lieutenant A's case study.

  - The discussion of the results of the analysis in the light of our interpretative framework. The discussion takes two perspectives : a topical one, that is to say the perspective under which the findings of the study can be used or critically analysed. Namely, the findings of the study of DMA, the experience of trauma in action and peritraumatic resilience are considered from the point of view of metacognitive training, i.e. training in advance people for potential Critical Incidents that might occur in the course of their (dangerous) activity. The second perspective is epistemological and exposes the limits of the methodological approach adopted in this study.

  - The general conclusions of the research and the identification of further research work.

The PCA process described in this section is made of a number of detailed tasks, intermediate objects, flows and results that are modelled in the following diagram :

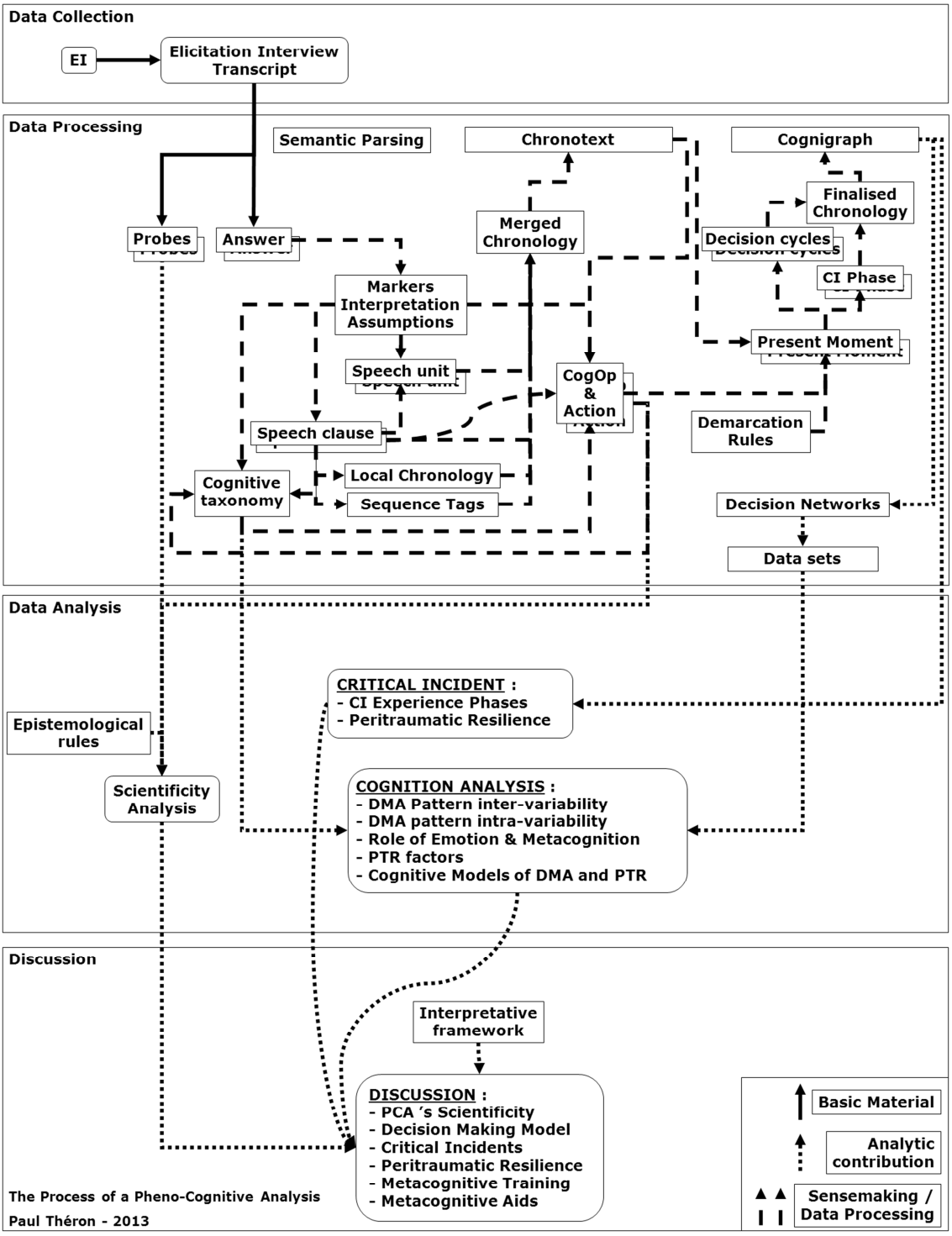


Figure 11 The process of a Pheno-Cognitive Analysis

The next chapter provides guidelines for the data collection phase.

CHAPTER 9. Data collection and the Elicitation Interview (EI)

This section is mainly based on Vermersch (2006). It presents the principles that guided Elicitation Interviews (EI) in this research. An EI helps an individual to recall from his Autobiographical Memory the *sequence* of actions and cognitive operations he performed during a particular episode of lived experience, along with their *textural features*[224]. This technique was used to collect the data of the central case of this research (Lieutenant A).

9.1. The immersion in the field of research

Researchers in social sciences, for instance Fivush et al. (1995, p. 344) and Ross (1991), adhere to the common idea that narratives are recreations of the subject's authentic experience aimed at allowing the *listener to experience the event with the teller*. In the context of a guided recall of episodic memories, an element of *intersubjectivity* between the interviewer and the interviewee is therefore present. The former must come on the grounds of the latter as highlighted by Varela & Shear (1999, p. 10) and Stern (2004). That coming on the same grounds is facilitated first by the recognition by the interviewee that the interviewer has real connections with his world of activity. This is one of the justifications of a preparatory immersion in the field, whenever it is feasible, before conducting Elicitation Interviews.

The immersion in the field of a PCA research is meant to get some "*knowledge of a minuscule human group by observing and describing their intimate singularities*" (Bloch, 2006).

It allows to understand what Bloch calls their "*tacit knowledge [...] that allows everyone to perform the numerous inferences that confer daily life with a manner apparently so little thought of*" (p. 21), "*the contextual setting of the task performed*" (Gallagher, 2007, p. 81) beyond their likely "*meta discourse*" (Bloch, 2006) made of "*standardised declarations provided as answers to expected questions*" (ibid, p. 41).

The researcher's insertion in the world of his target subject(s) can be performed according to Copans' (2005) recommendations :

- A unit of analysis : ritual activities, daily activities and exceptional circumstances;

- An object : subject's "*tacit knowledge*" (Bloch, 2006);

- A "participant observation" (Copans, 2005, p. 101) involving :

- A public and professional validation of the researcher by the community in which he is inserted. This can be done through a period of training shared with members of the community.

- The use of the community's language and codes : learning and speaking their language made of a lot of acronyms (CCOT, BCOT, BOT, BEP, PSR, ...), wearing their uniform, keeping hair short if they have it short, even resorting on the community's hairdresser services as a supplementary mode and sign of insertion, sharing the community's routine life (morning activities, lunch breaks, duty shifts, etc.), getting acquainted with managers, intermediate staff and men of the rank.

- A focus on observation more than on authorities' discourse : this is achieved by listening to conversations and exchanges between members of the community, victims, hospital staff and Firemen, etc., as well as to dialogs between command posts and vehicles dispatched in the field, etc.

- An organisation of the researcher's daily presence structured in five steps as in Copans (2005, pp. 36-42) : Arrival and installation, Integration and routine, Experience of surprising and critical moments, Departure, Follow-up.

9.2. Finding subjects

Subjects are selected on the basis of a suspicion that they might have experienced trauma in action. The process by which they are referred to the researcher should, as much as possible, guarantee the confidentiality of their participation. After they give their consent to take part in a Pheno-Cognitive Analysis, they must be called and explained the goals and principles of the study, and the researcher must check the likeliness of their traumatic experience, at this stage taking precautions not to disclose too much of the exact nature of the work to be done together in order to avoid that they start reconstructing their story beforehand. Having got their consent a meeting must be arranged for the Elicitation Interview (EI), at a location most convenient for them during their service. Similar precautions must be repeated at the start of the Elicitation Interview sessions to secure their good understanding of the research process.

The verification of the reality of their experience of trauma in action can be performed at the earliest during the EI, or a posteriori on the basis of the Immediate Stress Questionnaire (ISQ).

9.3. Contracting the EI and the "contextual priming" of phenomenal recollections

Contextual priming consists for the researcher to induce the appropriate attitude in the subject so as to frame, to orient his remembering onto authentic elements of his original cognitive experience : a given, delimited, situated, embodied and enacted episode of cognitive experience and the evocation of the authentic, original elements of cognition experienced by the subject himself during this episode. Beyond, contracting the EI means that the subject and the researcher formally adhere to the rules and conditions of the EI.

For Robinson (1995) and Bartlett (1932) the perspective set at the beginning of an interview session by the researcher shapes the subject's "*state of mind*" and his recalls. The subject's induced attitude guides his "*remembering. Attitude [being] an inclusive term covering motivation, emotion, and interests*" (Robinson, 1995, p. 200). Klein (1970) "*proposed a framework for relating individual emotional and cognitive styles to account for perception and memory*", Jenkins (1979) and Tulving (1983) who "*argued that a person's cognitive state is an important determinant of memory encoding and retrieval*".

Vermersch (2006) suggests to take great care of establishing an appropriate *relational climate* at the start of an EI session, a clear "*contract*" between the researcher and the subject that must be well understood by the subject and agreed by him (Vermersch, 2006, pp. 105-110). The main lines of this *contract*, which is the first step of *contextual priming*, include :

- Choosing a location and time convenient for the subject and quiet[225]

- Clarifying the fact that the interview is confidential and no personal data will be passed on to the hierarchy

- Explaining that confidentiality (anonymity) will be respected in later publications if any

- Clarifying the goals and method of the EI, the role of the researcher and of the subject

- Making clear that the EI has nothing to do with an inquiry

- Asking clearly that the subject delivers honestly data pertinent to the goals of the research.

More specifically, in Vermersch (2006)[226] it is recommended to explain to the subject :

- His right to pull off at any time without justification, especially if he or she feels uncomfortable. This echoes the common view, expressed by Gusdorf (1951), Van der Kolk (1997) or else Thompson (2007) that due to the high affective value of the mental states associated with the experience of Critical Incidents, very strong feelings could be triggered at recollection time, and therefore there is a risk of psychological disturbance for the subject (as well as for the researcher)[227].

- The methodological principles of the EI and especially what is expected from the subject :

    - A first-person narration of his or her experience; i.e. in the form of "*I* …" and NOT "*we* …" nor "*one* …"[228].

    - A narration bearing exclusively on the particular episode of experience, the intervention for which the subject agreed to take part in the EI, not his personal theories about what happened or what he or she should have done, nor his general knowledge of similar facts.

    - A narration of his or her own authentic experience : his / her own perceptions, feelings, thoughts, actions of the time, not the type of verbal report they would provide in an inquiry, nor socially correct ready-made phrases, interpretations, etc.

    - A true report of his or her experience, unfalsified, honest, and uncensored[229]. Vermersch, in a number of issues of Expliciter[230], insists on perlocutory effects, i.e. the impact on the other person of what is said or asked. It is important to say to the subject that he must not tell what he thinks might be interesting to the interviewer, but rather anything authentic that pops up in his mind during his or her narration.

From a formal point of view, Vermersch's (2006, pp. 108-110) recommendations match those of the British Psychological Society[231].

Contextual priming is a *sine qua non* condition of the evocation, the re-presentification (re-living) of the subject's past experience.

9.4. Principles of the Elicitation Interview : from recalls to evocation

Vermersch (2006, pp. 86-87, 57, 58, 59) presents the two theoretical principles of the *evocation* of a given past experience is possible :

- "***Re-presentification***"[232] : When narrating "*is not anchored in the situation of reference, most of the time it brings only unspecific, general, and often very poor elements of information [about one's experience] though [that experience] may have been very rich*", says Vermersch (2006, p. 58). *Re-presentification*[233] (Varela, 1999, p. 127) is the "*pure evocation*" narrative stance[234]. During the narration, *re-presentification* is a *re-living in thought now* the subject's past experience, including his *presence to his body-then*[235] *and to his world-then*[236], a *re-embodiment* and *re-situatedness* of that past experience. If properly primed (and guided) the subject "*at the moment he narrates a past situation, is present in thought to the lived experience of this situation*" (Vermersch, 2006, p. 57).

- and "***Subjective cueing***"[237] : Re-presentification means *to be in contact with one's past experience when narrating it*, (Vermersch, 2006, p. 58), and it is the interviewer's priority to constantly "*guide the subject toward this narrative stance as it is not spontaneous, being not encouraged socially, both in family education and school teaching*" (Vermersch, 2006, p. 59). It "*therefore requires active guiding, which constitutes an actual form of mediation*" (ibid).

The process of the evocation allows the subject to recall even *pre-conscious* and *pre-reflexive*[238] episodic memories[239].

9.5. Inducing the evocation : getting in touch with a past experience

The researcher starts inducing the evocation process as early as the start of the Elicitation Interview through contextual priming.

Even if the subject takes part in the EI on a voluntary basis, it is the researcher's role to induce the process. This is, says Vermersch (2006, p. 124), a most difficult task for the researcher who often "*creates himself difficulties by uttering negative-inductive formulations by multiplying questions and recommendations that complicate his task, create confusion in the subject's mind and orient the latter toward categories of recollective data which are not those sought after*".

To avoid such pitfalls, the researcher (Vermersch, 2006, pp. 124-130) must use "*simple, direct and positive formulations*". "*Positive*" means calling for the evocation in a first-person mode of the episode of experience under study, and saying to the subject *what to do* in this context rather than *what not to do*. The typical formulation is "*I propose that you take some time to allow the situation xxx to come back on your mind. I leave you find it. When it's there, just let me know.*"

Negative-inductive formulations are : "*don't be afraid to recall / stop whenever you wish, …*", "*can you remember …, can you try to remember …*", complex formulations (those articulated in several "logical" steps) as well as short ones like "*OK, now start telling me …*", vague ones that do not imply a clear explicitation contract like "*choose an episode within what happened …*", or imperative injunctions, even using the conditional, like "*I would like you to …*" have proved to induce negative reactions on the subject's part (Vermersch, 2006).

Evocation cannot be performed under constraint, but rather out of the subject's free will. It must not be experienced as a memory effort. Contextual priming, because it is accomplished prior to the induction stage, frees the induction process of the need to draw the subject's attention to the manifold, therefore confusing even if fundamental, requests and rules that frame the Elicitation Interview.

Sometimes, Vermersch (2006, p. 130) notes, the subject has difficulties to focus on his experience to reach a pure evocation stance of re-presentification. In that case, the researcher must probe a plain question that will help the subject to resolve the difficulty by turning his attention for instance to the very beginning of the episode, like "*what were you doing when it started ?, how did it start for you then ?*". Another way is to question the subject about what was happening just before it started : "*what were you doing just before it started ?*", "*how was the ambience just before it started ?*", "*had you noticed anything*

particular just before it started ?". The subject can then regain contact with his experience through an episodic memory easier to recall.

9.6. "Subjective cueing"

9.6.1. "Subjective cueing" : helping re-presentification

To help *re-presentification* during the whole duration of the EI, Vermersch (ibid, pp. 63-69) provides a number of cueing guidelines, applicable "*each time it is necessary*" (ibid, p. 63). Cueing can be as simple as in the following example[240] :

> "*51- I hear my voice.*
>
> ***52- You hear your voice, yes…***
>
> *53- I ask the girl to read again what she just wrote and I see myself following her reading with my finger in order to… There's something missing, a word or something like that.*
>
> ***54- Yes.***
>
> *55- And I would like her to realise that she forgot something.*".

But the narration may present difficulties and to help the subject in these circumstances, two types of probes can be used :

- <u>Probing questions unrelated to a specific moment of experience</u> :

  - To <u>slow down the pace of the subject's speech</u> : The subject may be narrating unstoppably, while in a very authentic manner, his phenomenal experience. This may be a sign that the interviewee "*is falling into prolixity or well-rehearsed speech*" (ibid, p. 64). Then, questions like "*please wait a second… I suggest that you take some time to reconnect more specifically with this situation…*", or "*take your time… and tell me when you are sure that you found it… you are there…*" (ibid) help him to calm down and to refocus. For Vermersch, subjects "*find a form of comfort in this rejoining oneself as they know they were falling into prolixity or well-rehearsed speech, and that they needed that mediation from the researcher to be refocused on one's actual lived experience*"[241] (ibid).

- To gain richer details about the texture of the subject's experience through textural cueing, i.e. a question that he can answer only with an evocation of his actual lived experience :

    - Either by probing questions relating to the context of the action (Vermersch, 2006) : "*for instance, you ask him where in the class he was sited, next to whom, with what pen he was writing, which objects were on his table, etc.…*" (ibid). Vermersch (2006) adds, "*it will be easy to abandon these cues as soon as the result will be gained […] and it is likely that they do not call any available autobiographical memories as they are inessential [but] it will help the subject not to resort on his 'intellectual' memory, and not to proceed to a reconstruction, [and] although the result cannot be guaranteed […] these cues will help the subject to represent for himself the actual context, his past reality will start to exist again*"[242] (pp. 64-65),

    - or, alternatively, and provided the subject is actually re-living his experience, by probing a *question [about] the sensory texture of the subject's representation of his experience* (ibid, p. 65). In this case, "*the questions will temporarily bear, not on the actual past lived experience (of the reference situation), as with the prior technique, […] on the content of the evocation, but on the structure of that evocation*" (ibid) by asking the subject "*whether he has visual images of it or not, or a particular sensation associated with it when he reconnects with the original situation*" (ibid), and next to indicate if it is a sound, a word uttered, etc…, a sensory modality "*more easily accessible by the subject*" (ibid). That second technique "*does not aim at yielding pieces of information, but at guiding the subject toward the evocation of the reference situation*" (ibid).

- Probing questions focused on specific moments of the narrated experience : They seek to reconnect the subject with a particular moment in the flow of his experience by placing him in a position of "*hearing elements of his own experience presented to him by the researcher, elements that speak directly to the experience that the subject knows, as it is his own, so that he fills in the gaps left by the vagueness of the researcher's formulations*" (ibid, p. 67). This technique, which uses the very content of the narration as its starting point, must be applied with care as it is easy for the researcher to be inaccurate and consequently to force the subject to come out of evocation to understand

the meaning of what the researcher is suggesting : "*no, I didn't say that*" (ibid, p. 66) is the subject's reply in that case. Three techniques are usable here, depending on whether the researcher has "*a starting point*" (ibid, p. 67) on hand or not :

- Ericksonian reformulations : Specific moments within the flow of the subject's experience provide the researcher with starting points. In Vermersch's (2006, p. 67) example : Subject : "*Yes, I see the place where I was sitting…*" ; Researcher : "*And when you see this place, as you are seeing it right now, what do you see ?*". The threefold structure of this question is purposeful, says Vermersch (2006) : "*The first part is a simple probe, in echo, [on which the researcher] can base the formulation of his own probe […,] the second part, a subtle one, speaks to the subjects about his own experience, without naming its contents, only pointing to it, recognising its existence and its presence [and] it guides the subject toward his inner experience*". The third part of the probe constitutes a "*cognitive challenge*" (ibid). If the researcher makes this cognitive challenge equally *engaging*, *real* and *manageable* for the subject, he may successfully trigger the evocation of the latter's experience (Vermersch, 2006, pp. 84-85).

- Pseudo-connectors : They are less sophisticated, but still "*efficient*" probes (Vermersch, 2006, p. 68). They are typical formulations used to begin probes : "*and when…, while…, while you keep doing…*" (ibid). They facilitate the continuation of the subject's narration and are a way to insist on specific moments of the experiential flow.

- Absolute formulations : They are "*formulations impossible to refute*" (ibid) that "*help the subject, while he regains contact with his own experience, to reach a re-presentified narrative stance by suggesting he focuses his attention on a sensory modality for instance, or on an aspect of the context […,] without introducing disturbing*[243] *formulation [by using an ericksonian] reformulation that covers all potential aspects [, which] whatever reality be are included in it*" so that "*among all possible propositions, the subject will pick one up that matches his experience and will neglect others*" (ibid). Formulations are for instance : "*maybe you find images, but maybe not, only you can tell*", "*maybe you recall images, unless they be sounds, or sensations, something that you are re-experiencing*"[244] (ibid).

9.6.2. "Subjective cueing" : encouraging and regulating episodic recalls

Another function of subjective cueing is to encourage the subject to sustain his efforts until the moment is reached when the evocation can go no further (exhaustion of the story). Secondly, the evocation is usually punctuated of recollections of particular moments and in the flow of the narration, it is difficult to discern them. Hence also the need to slow the pace of the narration.

Encouraging the explicitation process consists for the researcher :

- Either, when appropriate, when there is a short blank in the narration for instance, in keeping silent or humming, smiling or nodding, a discrete sign that tells the subject that the researcher is with him, in close contact,

- or when the subject makes a short pause, in resorting on one of the probes presented earlier.

9.6.3. "Subjective cueing" : filling gaps and enriching the evocation

typically, after twenty to thirty minutes, the subject terminates a first round of narration. He has browsed through the story from beginning to end.

At this point a brief critical review of the material gained must be performed by the researcher in order to detect and evaluate the holes in the phenomenological account of the story.

Using probes, he must then try to refocus the subject's attention on key moments. The researcher must be attentive to the fact that the subject may have rejoined the present of the interview session, or gone into a reflection upon its meaning and abandoned his story. This process of reconnection must be repeated in sequence for each of the identified gaps. Formulations such as "*And when you see this place, as you are seeing it right now, what do you see ?*" can be used.

9.6.4. "Subjective cueing" : Tying together the elements of the story

When the subject narrates his inner experience, he does not proceed in chronological order, from beginning to end. In the course of his narration, some facts trigger the recall of further details or segments of experience, for instance because they are explicative of the dynamics of the story, or because the subject realises he left a gap in his narrative. The

researcher is left with an untidy situation : bits and pieces of evoked experience, obvious holes in its account, abandoned chunks. He must then proceed to a tying-up of these elements.

He needs to quickly put together the elements of the narrative to reconstitute its storyline and identify its missing segments. Then, using the moment-specific probes presented earlier in order to, he can guide the evocation from narrated moments to give the subject a chance to evoke the missing moments.

The typical question to use in such a case can be focused plainly on the course of action : "*and at that moment, what do you do ?*", or on the course of events : "*and at that moment, what happens ?*", or on the changes in the nature of the experience : "*and at that moment, does something change around you ?*", "*and at that moment, do you feel something happening in you ?*", or on the texture with a focus on sensory aspects as in : "*and at that moment do you ear or see something in particular ?*". This last type of probes helps the subject to reconnect with the textural elements of his experience, and, from there, with its procedural aspects.

9.6.5. Further comments on subjective cueing

As far as possible, the researcher should avoid questions that bear on the *already-made-conscious*. Rather, he should ask the subject to depict what he has done as "*what do you do when you perform such act ?*", "*how do you do it ?*" (ibid, p86), or "*guide the subject toward a textural evocation*" (ibid, p. 97).

9.6.6. Signs and further probes for monitoring and regulation

Vermersch (2006, pp. 60-63, 111-116, 139-140, 161-162) provides guidelines for efficient re-presentification monitoring.

Re-presentification, pure evocation, Vermersch (2006, p. 60) reminds, "*is a private fact, not directly observable, except by the subject himself*", and monitoring that the subject has reached and keeps that narrative stance requires "*indicators both verbal and non verbal*" (ibid). Indicators and regulation means can be :

- Eye redirection, and sensory synchronisation : "*Accessing the re-presentification stance translates mainly into a redirection of the eyes*" says Vermersch (ibid, p. 161). Based on lessons from neuro-linguistic programming Vermersch (ibid) indicates that

when a subject keeps looking at the researcher his attention has not refocused on his past experience. Would he have redirected his attention to the past situation, his eyes would redirect upward or downward, to his right or left. Vermersch (ibid, p. 114) summarises this : the subject's eyes quit the researcher and look upwards when the subject's evocation is based on a visual picture[245], downwards when it is associated with his intimate inner experience (turning to the subject's right if evocation makes reference to feelings or sensations, to his left when referring to thoughts), and eyes redirect either to his right or left when the subject's evocation is rather auditive). Individuals very much acquainted with the practice of evocation can sometimes keep their eyes centred and unfocused like in day-dreaming (ibid). In consequence :

- Should the subject's eyes indicate that he has not switched his attention toward his past inner experience, the researcher should resort on the probes mentioned earlier to (re)focus it.

- Should the subject's eyes show a given sensory mode of evocation, the researcher should be attentive to formulate his probes accordingly (Vermersch 2006, p. 116) in order to accompany the subject in his present mode of evocation rather than disrupting it and forcing the subject to enter a different mode, e.g. if in auditive mode, to ask questions in relation to the visual experience of the subject, etc.

- <u>Speech pace and tone, and verbal synchronisation</u> : Vermersch (2006, p. 61) suggests that when subjects are in the re-presentification narrative stance, their speech pace may slow down as their cognitive – retrieval – activity is resource consuming and elements of his past cognition only come slowly one after another. He adds that this is especially true of experts whose semantic knowledge being vast seek the right words to describe their experience adequately (ibid). they can also narrate their experience sometimes on a fairly fast pace, sometimes in a very hesitant, hectic manner. Vermersch (2006, p. 111) also notes that sometimes there are pauses in the subject's narration : they correspond to the time needed to access his Autobiographical Memory. In consequence :

  - Should the subject's speech pace indicate he has difficulties in the evocation process, it is to the researcher, Vermersch (2006, p. 112) says, to adjust, either by progressively slowing down the subject's pace after rejoining him initially, or by

adopting a similar tone of voice, loud, intense, soft, very quiet, etc…, without imitating the subject grossly though.

- Speech tone must be adjusted by the researcher to the subject's as early as the induction stage : in those moments, says Vermersch (ibid), the best the researcher can do is to remain silent as much as possible to let the subject reconnect quietly with his past experience, and he should speak in a very mild voice to probe cues only if the subject needs some help to reconnect with his episodic memories.

- Congruence of verbal and non-verbal indicators, and other synchronisation modes : Basically, Vermersch (2006, p. 62) suggests that a feeling narrated by the subject is usually matched by a bodily expression that enacts it. For instance, a sad face for the evocation of past sadness. Vermersch reminds that "*bodily expressions are not conscious and thus stand little chance to be altered by the subject*" (ibid)[246]. In consequence :

  - With regards to non verbal indicators themselves, it is necessary for the researcher to synchronise his own posture with the subject's, for instance by adopting a similar position of the body, laughing or smiling with the subject, performing similar micro-movements (like scratching one's ear, crossing legs, etc…) says Vermersch (2006, pp. 112-113).

  - Should the subject gesticulate, "*it would not be appropriate to copy him*" (ibid, p. 113), but rather to accompany the formulation of probes with bodily movements that subtly echo the subject's, for bodily movements, as said already, enact one's mental processes. Echoing the subject's movements echoes his cognition and therefore encourages it.

- Linguistic markers : The main marker provided by subjects who are in a re-presentification stance is the use of the first-person, often in the present form, sometimes using the past, with few evaluative, judgmental utterances. The use of "*one*" ("*on*" in French) may be expressing a rather spectator-like narrative stance, or a culturally-induced formulation. This view seems to be supported by the study of Bruner & Fleischer Feldman (1995) who report that individuals "*with the highest sense of [group] internal coherence and dedication*" use the plural first-person "*we*" significantly more often in their autobiographical narrations than more individualistic

members of social groups with a lesser sense of common and strong identity and less sharing common principles. But it can also mean "*we*" or relate to a generalisation of the subject's experience. In both cases the subject is not in the pure evocation stance likely to yield authentically phenomenological narratives. In consequence :

- Should the subject be in a "*one*" mode, the researcher may always attempt to clarify the meaning of that "*one*" formulation. To that end, with a risk of disrupting the subject's evocation, the researcher may ask fairly direct questions, though precautionously introduced. If in relation to an act in the physical world : "*Hold on a second… When you say 'one', is it you who does this ?*", "*I propose to you to stay on this moment for a second : is it you who does this or is it someone else whom you see or ear maybe ?*", "*who says this then ?*". If in relation to a cognition : "*hold on a second : at that moment, are you personally thinking this ?*", "*I propose to you to stay for a minute with this moment, when you think this : is there anything around you that makes you think so ?*".

- When "*one*" is used abundantly by the subject, it is also necessary to monitor as many non verbal signs as possible in order to assess his narrative stance, re-presentification vs. generalisation or reconstruction.

- <u>Doubts and expressions of impossibility</u> : Sometimes (Vermersch, 2006, pp. 161-165) the subject may express his inability to reconnect with his autobiographical memories : "*I cannot remember*", "*I don't know*", or he expresses doubt about what went on : "*I am not quite sure*", "*it's something like that but I am not sure*". This situation may arise from the fact the subject tries to "*keep control of the researcher*" (Vermersch, 2006, p. 161), or because subjects may find it difficult, and even taboo, to talk about themselves : "*During educators training sessions, it is not infrequent that trainees have got used to talking about themselves, i.e. about their pupils, and it is sometimes hard for them to accept the personal involvement it takes to talk about 'what I do' rather than talking about 'what they do' "*[247] (ibid). It may also be an authentic doubt or the subject, unfamiliar with the evocation process, cannot think that it is possible for him or her to access his own autobiographical memory (ibid, p. 162). The researcher, without trying to understand why this happens, must help the subject who otherwise may feel blocked, trapped in the process, and terminate it (ibid, p. 163) :

- A first approach to this difficulty is to check, in a direct manner, with the subject "*if he knows, if he really is back into the past situation*" (ibid), to bring him to an "*evaluation of his own evocation to help him get hold of an evocation closer to him by helping to formulate his own criteria*" (ibid).

- Another way is to create a *counterpoint*, says Vermersch (ibid) : "*instead of trying to reach what is known of what was going on, it is possible to work from the certainty of what is doubted*", and he provides an example from classroom experience, of which this excerpt[248] :

  ***Researcher** : When you do not understand, what do you already understand ?*

  Subject : I got an answer, but what was it ?…

  ***Researcher** : In what position are you at that moment, when you hear yourself again speaking ?*

  Subject : Was I standing ? I don't know, it's really annoying that I cannot retrieve the situation […]

  ***Researcher** : Nothing at all… What do you know that there was not ?*

  Subject : What I know there was not ? I know that I didn't get anything in relation to my goals […].

To conclude, Vermersch (2006, p. 165) adds that "*regulation starts each time the researcher realises that he has to make too much efforts to get the Elicitation Interview going*".

9.6.7. When to probe ? Another perspective on opportunities and signs

When can the researcher finds opportunities to probe cues or to regulate the evocation process ? Coulthard (1985, pp. 61-69) provides several indications that may help the interviewer to probe cues adequately, at precise ad hoc moments, without disrupting the evocation process :

- Precise interruptions : A "*conversation is made up of units which are recognizable as either incomplete or possibly complete and [indicate] that next speakers can begin as soon as a current speaker has reached a possible completion*" (ibid, pp. 61-62) : speakers can interrupt each other and "*place their entries with great precision*", 1) by producing "*a completion to a prior speaker's otherwise complete utterance*" with a form of ericksonian reformulation that summarises the prior speaker's idea : "*just like that ?…*" ; 2) by "*coming in just at the right moment [with his] own proposed completion of an as yet uncompleted sentence*" : the interviewer, while the interviewee is about to finish a sentence, voices over his own termination to induce a change of perspective in the interviewee's mind : for instance, the subject says "*I can see the green truck that drives straight on*" and as he says "*that*", the interviewer speaks over "*that makes no noise*" for instance, thus inducing a switch from *events in the world* to *auditive sensory modalities* ; 3) by predicting "*the ending of a sentence and [attempting] to say the same thing at the same time*" as the current speaker : both the subject and the interviewer end the prior sentence saying *that drives straight on*.

- Silence : Silence is *very little tolerated between turns in a conversation* and "*if the intended next speaker does not begin almost at once the previous speaker is likely to produce a post completor*" : in the case of an Elicitation Interview, the subject will either restart his narration in a way that seems best to him, or will manifest a need for some guidance. The researcher must not remain inactive.

- Request from the subject that the interviewer takes turn : In that last case, the speaker – the subject – can prompt some "*turn signal*" (ibid, p. 68) to let the interviewer know that he wishes him to take over. These cues can belong in six categories : 1) a change in the intonation of the voice, 2) a "*paralinguistic*" change like drawling on the final or stressed syllabi of his last sentence, 3) terminating any hand gesticulation or relaxing a tense hand position, 4) using stereotypical "*sociocentric*" expressions like "*but uh*", "*or something*", "*you know*", 5) using a combination of paralinguistic change and a sociocentric expression, 6) or just completing his sentence to silence while "*assuming a characteristic head posture and by looking steadily at the auditor before [actually finishing speaking]*". When the researcher, "*who spends most of his time looking at the speaker*" (ibid, p. 67), perceives such a *turn signal* he has to respond.

- Request from the subject to speak uninterruptedly : Sometimes, the speaker just "*wishes to continue speaking past a particular 'possible completion'*" (ibid, p. 64) of

the current segment of his narration as he may feel some pressure from the interviewer to take turn, and then he uses an "*utterance incompletor*" (ibid) such as, for instance : "*but*", "*and*", "*however*". The speaker may also want to make it possible for him to utter "*a fairly large unit of speech*" or "*at least two clauses*" (ibid) : in that case, the speaker will start a new segment of his narration with respectively a "*pre-structuring*" device such as "*two things happened then…*" or "*first…*", or an "*incompletion marker*" such as "*if*" or "*since*".

9.6.8. In conclusion : a taxonomy of probes

In summary, probes have three functions, says Vermersch (2006, p. 121) :

- Focusing, i.e. 1) to induce the evocation process, 2) to stay on or return to an already narrated moment or cognitive operation to augment its phenomenological description and fill its evocation gaps, 3) to suggest an angle not already used like a sensory aspect never mentioned by the subject in order to explore further how the action was produced and experienced, which requires that the researcher be attentive to the taxonomy of the phenomenal data already uttered by the subject and to his own probing that can fail to cue certain evocation categories of phenomenal data.

- Elucidating, i.e.1) to clarify cognitive objects evoked by the subject, 2) to clarify or establish the chronological order of several cognitive operations which seem to the researcher not to be positioned in a correct sequence by the subject, 3) to resolve what appears as contradictions to the researcher, 4) to lift doubts in the subject's mind, 5) to "*clarify how action's efficiency or inefficiency was produced*" (Vermersch, 2006, p. 135), 6) to clarify the evocation category under which evoked cognitive operations fall when they are not clear to the researcher, 7) to check the accuracy of the narrative provided by the subject, 8) to clarify whether the speech mode used by the subject ("*I*" vs. "*one*", but not when "*we*" or "*they*" are used as these are clearly incongruent with a pure evocation stance) relates to a pure evocation narrative stance (does "*one*" equal "*I*" ?).

- Regulating, i.e.1) to help the subject to return to a pure evocation stance, re-presentification, should he introduce in his narration elements of evaluation of his experience, general theories of his life experience, elements of his wider context rather than about the single episode of experience under study, or elements from another episode, 2) to help the subject remain on the right level of description of his

experience, the Episode, its Present Moments and their sub-summed cognitive operations or actions.

ANNEX 3 summarises subjective cueing tips.

9.7. The validation of the EI

Vermersch (2006, pp. 178-180) equates validation of first-person narratives to the issue of their veridicality. In the context of the EI, some notions should be clarified however.

Veridicality is the production of *authentically phenomenological* recalls of the facts of a lived experience, can be guaranteed under two fundamental conditions :

- A deliberate focus on a single episode of lived experience, in order not to mix data from different episodes.

- Re-presentification, the authentic, pure evocation of the experience of this past episode, rather than social reconstructions, generalisations and retrospective theorisations. This can be obtained through induction and subjective cueing.

Validity is the adhesion to the principles for conducting the EI, and its minimal conditions are :

- An attentive, trained, detached, sensible interviewer, capable to come on the same grounds as the subject

- The way the interview is conducted : it must yield a pure evocation stance, within a clear contract, after context priming and through induction and subjective cueing.

- Loyal transcripts of EIs, from audio records.

- The *phenomenological authenticity* of the subject's evocation, that must be evaluated by the researcher both as he proceeds and after the narration.

Validation is the verification by the researcher, or preferably by a peer, of the *veridicality* of the narrative and of the *validity* of the process.

The evaluation of the phenomenological authenticity of the narration determines whether or not to process the narrative further. Unauthentically phenomenological narratives should not be processed. Only authentic narratives can be further processed, i.e. transcribed from audio records and analysed. In some cases, like a frequent use of "*one*" instead of "*I*", a retrospective verification of authenticity is needed if it has not been possible during the EI.

In Lieutenant A's case, the following signs of an authentically phenomenological narration are :

- The spontaneous use of the "*I*" speech mode and of the present
- Voice intonations : quasi-stammering, hesitations, variations of the speech pace
- Narration was mainly centred on facts, little on their retrospective interpretation
- A "direct evocation" stance : drawing a sketch and referring to it, quotation of others' utterances, eyes redirection
- No *a posteriori* social reconstruction : when triangulating on specific moments[249], the formulation of the details of those moments differed slightly indicating that the story had not been learnt but rather that it was being recalled each time, each re-evocation of a given moment having brought new details.

9.8. The transcription of the Elicitation Interview

Elicitation Interviews must be, at least, audio-recorded[250]. A loyal transcript of the audio-recorded narrative must be produced by the researcher. Coding convention must remain simple : they must a minima distinguish the researcher's questions from the subject's answers.

9.9. Synthesis 1 : the process of the Elicitation Interview

An Elicitation Interview must be performed based on the following process :

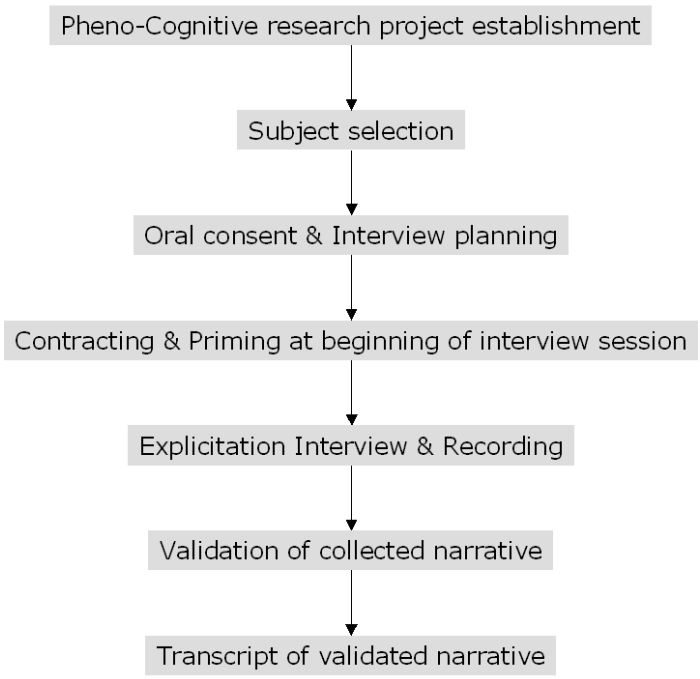


Figure 12 The process of the Elicitation Interview

9.10. Synthesis 2 : the dynamics of the Elicitation Interview

As shown earlier, the Elicitation Interview is a staged process controlled by a feedback loop :

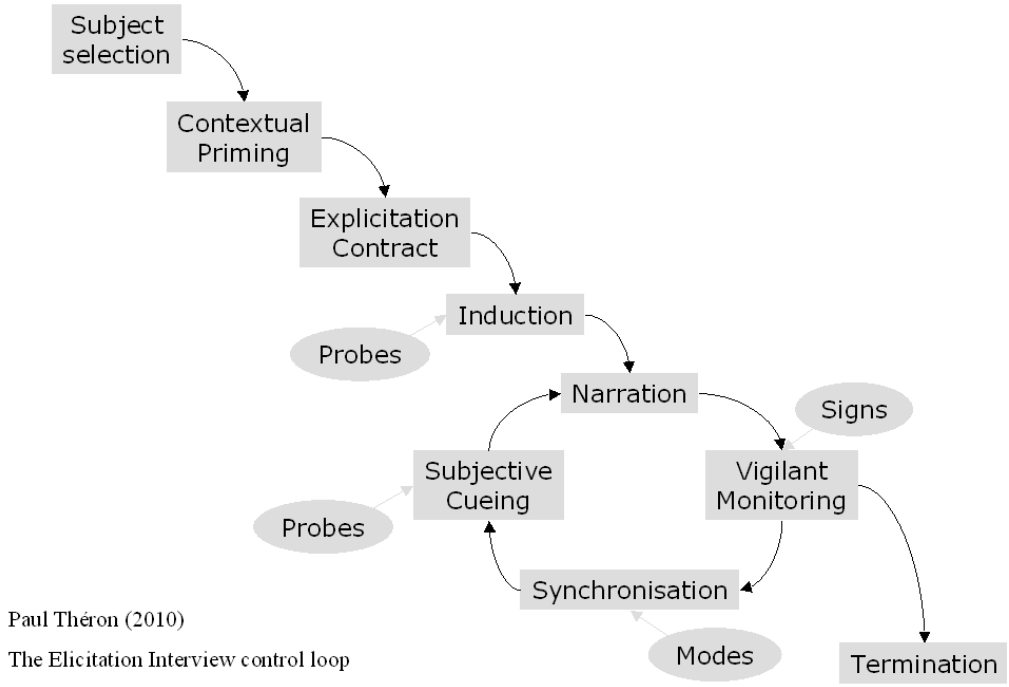


Figure 13 The dynamics of the Elicitation Interview

9.11. In conclusion : a clear focus on recalling authentic episodic memories

What really distinguishes the Elicitation Interview from other techniques[251] is its systematic guidance of the subject toward a *pure evocation* narrative stance, i.e. an exclusive interest for the subject's access to his episodic memories of the authentic details of a given episode of his cognitive experience.

What we call *phenomenological authenticity* is the recall from his episodic memory of the phenomena (his actions and cognitive operations) the subject authentically experienced, from his own subjective perspective, at the time of his actual episode of action. Phenomenologically authentic recalls are void of, i.e. exclude a posteriori social reconstruction, interpretation or theorisation. It is the Elicitation Interviewer's role to guide the subject's recall away from these biases. It is also his role do discard from his research narratives that would be biased in such a manner.

To achieve this ambition, this chapter has codified the principles and rules of the EI in a fashion that should benefit later researchers in their attempts to study the cognitive processes of people's episodes of experience.

The next chapter presents the data processing stage of the Pheno-Cognitive Analysis method. Data processing starts from the transcript of the first-person narrative of the subject's experience. It aims at eliciting the data describing the subject's cognition in a fashion that will allow, at the data analysis stage, the researcher to build his knowledge of studied cases in terms of taxonomy of cognitive operations, of cognitive trajectories and patterns, and of frequencies and order of apparition of these patterns and cognitive operations.

CHAPTER 10. Data processing (phenomenography)

Even if phenomenologically authentic, a first-person account of the experience of a Critical Incident in the course of an intervention is all but ready to be analysed. It is *messy*. The narrative does not follow the chronological order of the actual course of things. It is unstructured, sometimes unclear, redundant. It has gaps. It is not uttered so as to help the researcher discern the cognitive operations performed by the subject and their sequence. It includes the researcher's questions (probes) and the subject's answers. There is jargon, etc.

Some processing of the raw material thus gained from the EI is therefore necessary before data analysis can start. This section presents the process elaborated for data processing. First, we present the semantic analysis process through which the objects of a phenomenography are elicited from the narrative. Secondly, we present the cognitive modelling techniques developed in the research, the cognigraph and decision networks. They are the foundations of the later data analyses. Finally, we present the concepts of a phenomenographic database as it helps manipulating and tracing the large amount of data yielded by the narrative and the discovery of the phenomenographic objects.

10.1. The objects of a phenomenography and their elicitation

Data processing aims at producing a reliable, formal (structured), and verifiable description of the narrated episode of cognitive experience, to allow its later analysis, a phenomenography. It starts with the elicitation of its objects :

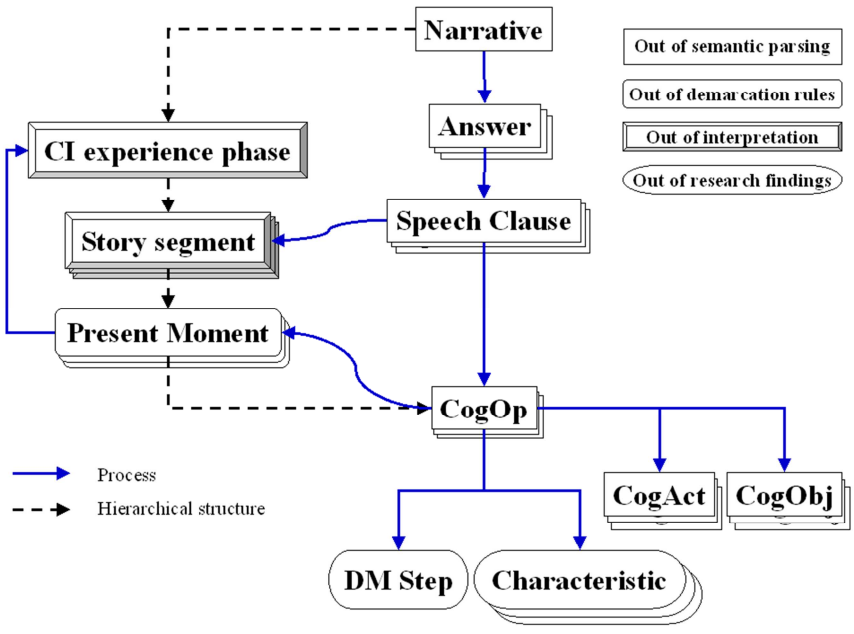


Figure 14 The general model of the objects of a phenomenography

The elicitation of the elements of the model takes the following steps :

- The ***semantic parsing*** of the *Narrative* separates the subject's *answers* from the researcher's probes. Answers are broken into *Speech Clauses* by looking for *semantic markers* and *sequence markers*. Speech clauses are put into chronological order within *speech units*, which are meaningful *segments* of the subject's story that facilitate the chronological reordering of the narrative. *Sequence tags* are posted at this stage to indicate how different speech clauses from different answers should rejoin chronologically or be merged for their respective semantic markers indicate they relate the same chunk of the subject's experience.

- Secondly, the elaboration, out of the parsed transcript, of a ***chronotext*** that reconstitutes the *chronology* of the whole experiential flow. Sequence tags help to merge and resequence speech clauses.

- The semantic analysis of each resequenced speech clause ***elicits*** the occurrence of an *action* (in the world) or of a (or several : a *sequence*[252]) *cognitive operation* (CogOp). A *taxonomy* of *Cognitive Acts* (CogActs) and of *Cognitive Objects* (CogObjs) forming CogOps is elaborated. CogActs and CogObjs are defined in two steps : first, detailed *sub-types* are identified during the semantic analysis of Speech Clauses; secondly, they are grouped in generic *types* to manipulate a reduced set of concepts. The chronotext helps to finalise the chronological sequence of CogOps = pairs of {CogAct ; CogObj}.

- The elaboration of the ***cognigraph*** is derived from the chronotext. It graphs the chronological chain of CogOps and actions that form *Present Moments* and helps to demarcate the latter[253]. The sequence of Present Moments helps to identify *CI experience phases*, which correspond roughly to turns in the story plot with different *emotional tones* of the experience of CIs : nominal (non stressful, non traumatic), stressful, traumatic.

- Each CogOp can later be ***interpreted*** and further described by a set of *characteristics* to analyse the cognitive process of Decision-Making-in-Action and to model this process as in NDM research. They can also be ***grouped*** into higher-order decision-making steps (DM Steps) that simplify analyses and diagram reading.

10.2. Conventions for the semantic parsing of the narrative

10.2.1. Writing conventions for the transcript of narratives

Conventions used for transcribing the narrative from audio tapes are only a few.

Each of the researcher's probes and subject's answers must be numbered and identified as question or answer.

(ss), (pff), (nss)	mouth noises the interviewee made within his utterances
[était] / [was]	missing word inserted by researcher to clarify the interviewee's utterance
{xxx}	a comment or observation inserted by the researcher within the text of the interview
---	a pause made in the course of speech, and a measure of its length in number of "-"
<XXX>	information replaced by the researcher to guarantee anonymity of the narrative.

Table 14 Writing conventions for the transcript of narratives

10.2.2. Conventions for semantic parsing

A good understanding of the interviewee's language, as well as a good knowledge of his occupational context's culture and language, are necessary to detect illocutory meaning in the subtleties of the subject's utterances. Hence the preparatory immersion in the field.

Speech Units : Usually, as seen in all narrative grammars (Kintsch & Van Dijk, 1978 ; Mandler & Johnson, 1977), a narration starts with an exposition phase : "once upon a time" is the best known one, but subjects will simply start with "*Well… I was waiting by the call desk…*". From there on, the episode reveals a sequence of meaningful sub-episodes, consistent segments of the story, named *speech units*[254] : 1) hearing the report of an emergency call about two dog-bitten women, 2) paying more attention to it later on as further news indicate it's a serious case, etc.

Speech Clauses : They are basic propositions found in the subject's *answers* out of one or out several semantic markers. Speech clauses are short and say only one thing at a time like "*and then I forgot*", or "*and then I forgot I wanted to tell him to rush upstairs*". They may be ambiguous despite or because of their shortness. Should a speech clause reveal or let the researcher assume the occurrence of several CogOps, it must be "duplicated" in the chronotext and numbered as many times as there are CogOps stemming from it. Sometimes, the researcher will aggregate several speech clauses describing the same CogOp into a single one. In this case, a "+" sign should be inserted between the assembled propositions forming the speech clause.

Semantic Markers : They are signs of the performance by the subject of a cognitive operation, i.e. of its cognitive act or cognitive object, or of an action : nouns, verbs, complements, onomatopoeias, and any other element present in the narrative. The conceptual model of the semantic analysis is very simple :

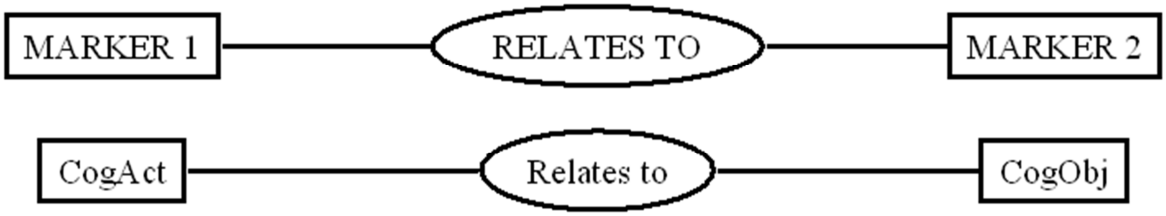


Figure 15 The conceptual model of the semantic analysis of speech clauses

But the simplicity of this conceptual model masks the principle difficulty of a semantic analysis. In this process, it is very easy to hesitate to deduce semantically a CogAct or a CogObj from a set of words composing a speech clause as the initial material may take a number of shapes (Watson, 2006) : a single word, an onomatopoeia, a group of words sometimes spread across several speech clauses, jargon, etc.. Some principles were elaborated to resolve this issue :

- CogActs are the “performance”, the “processing” of CogObjs. CogObjs are the “what is processed” by CogActs.

- A basic heuristic consists to designate CogActs strictly by verbs (in the active form avoiding “to be” and “being” as far as possible), and CogObjs strictly by nouns.

- What semantic markers point to during the semantic analysis are in fact very finely “nuanced” verbs and nouns found in dictionaries. They name the basic “sub-types” of cognitive operations, CogOpST = {CogActST ; CogObjST}, that can be summed into a higher-order “type”, a CogOp = {CogAct ; CogObj} :

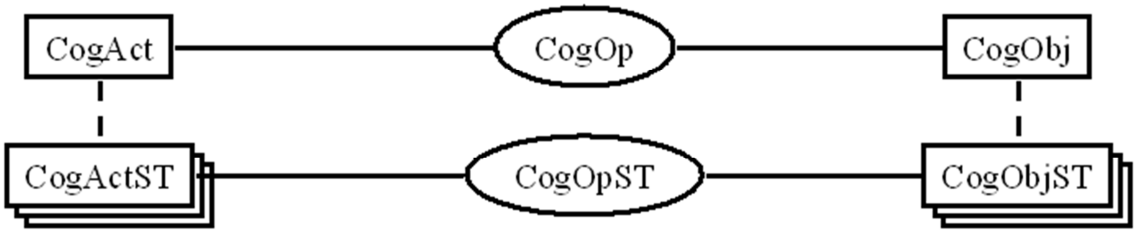


Figure 16 Types and sub-types of CogAct and CogObj

As the sense of a speech clause may be not immediately clear, the narrative's semantic parsing may be a recursive process.

One of the principal difficulties is to become capable, repeatedly, of *open listening*. By this, we mean the researcher's faculty to read *plainly* a clause. Words often mean exactly what they say.

For instance : "*to, well…, catch the dogs and to put them into –well- into a box*" :

- "*to*", and Lieutenant A's main preoccupation on the dogs front is to have them collected by the dogs unit and to make the place safe ("*to put them into –well- into a box*") are semantic markers helping to identify a CogOp made of :
    - A CogAct = Tending toward ("*to*")
    - And a CogObj = a Goal ("*catch the dogs and to put them into –well- into a box*").

However, referring to the subject's general cultural and cognitive background is always necessary to avoid misinterpretations. Hence the usefulness of the initial immersion in the field.

Some utterances are rather difficult to interpret. Others reflect the difficulty for the subject to search and retrieve episodic memory traces, and onomatopoeias (words formed from sounds) are very common in the course of a narration. Some may express an internal process of reconnection with memories. For instance :

- "hmmm…" expresses surprise or interrogation or a momentary hesitation or disorientation
- (nss), (pfff) are noises made with the teeth or the lips : their meaning is difficult to grab :
    - (nss) here may express some internal interrogation or conflict in relation to the order in which memories should be voiced ; memories pop-up and there is a difficulty in the subject's mind to sequence his narration

- hhhmmm--- may express the subject's internal effort to recall an element of experience.

Contractions, for instance "*there's*" instead of "*there is*" are not significant.

Hesitations, repetitions and quasi-stammering are also frequent. They may express emotions, a memory retrieval effort, or an internal verbalisation priority conflict like in :

"and I was at the call desk and hhhmmm there's there's – hhhmmm---"

Technical jargon is used by subjects in their narration : it is important for the researcher either to be acquainted with the interviewee's milieu, or to ask him for clarifications after the interview :

"*in addition to that **VRV**[255] there's there's a **pump** that went*".

Assumed vs. Certain CogAct : Another difficulty lies with the level of "certainty" of the semantic elicitation of CogActs, hence of CogOps.

As said earlier, a narrative may have gaps and some cognitive operations may be felt missing by the researcher. On what grounds can the researcher elicit *missing CogOps* ?

For instance, one practical question is : can a cognitive process fire an action without any prior form of decision ? From time to time the semantic analysis of speech clauses may not allow to elicit such a (decision → action) sequence, and it looks like the subject has "fallen into action by chance". NDM models such as Klein's RPD model associate systematically an action with a prior decision (made and evaluated in a deliberative manner).

Alternatively, in the reality of individual cognition, action can also result from[256] a physiological "need" or "drive" (Zajonc, 1965), a "motivation" (Arnold, 1960)[257] as in Hobbes' (1651) theory of hedonism, or from Freud's *instinctal impulse* (Laplanche & Pontalis, 2004). Nowhere in psychological research the possibility to act without some form of prior motivation or decision is suggested. An urge to act is usually associated with an emotion (Frijda, 1993 ; Mosier & Fischer, 2010). When such an element can be identified during the semantic analysis of a speech clause, it is systematically parsed into the sequence of CogOps suggested by the high-level model of coping presented in chapter

2 : Appraisal → Arousal / Affect → Coping. In this second case, “Action” then follows, and stems from a “Coping” cognitive operation.

Therefore, as a convention reflecting this established fact, an action is always preceded by either a form of psychological “emergency” or pre-reflexive “urge”, or by a deliberative decision. When not expressely narrated by the subject, this prior cognitive operation is “*assumed*”. When narrated and clearly recognised by the analyst, a cognitive operation is deemed “*certain*”.

There may be other circumstances in which some CogActs (and therefore CogOps) are assumed rather than certain. The analysis of a speech clause echoes with the elements of the research field’s background culture gained from a preparatory immersion. A simple speech clause can suggest that a number of cognitive operations have been performed but not narrated.

For instance, in the speech clause from Lieutenant A’s narrative “*as for me now, bitten by a dog… maybe there's something more serious to come up.*”, we can say that the subject :

- evaluates the situation (does it deserve that I go vs. staying at the station ?)
- evaluates it's not so serious ("*bitten by a dog that's not*---")
- knows he is not supposed to intervene unless serious case (from regulations)
- knows from experience more important cases may appear (“*something more serious to come up*”).

The following cognitive operations (sub-type level) are then identifiable :

PM#	CO#	Status	COGACT (sub-type)	COGOBJ (sub-type)
01	6	CER	Evaluating	Severity of the situation
01	7	**ASS**	Remembering	Regulation
01	8	**ASS**	Anticipating	What could happen (how the situation might evolve)
01	9	CER	Considering	Options for action (go or not go)
01	10	CER	Weighing Pros & Cons / Comparing / Pondering	Options for action

Table 15 An example of assumed cognitive operations

Sequence Markers : Another difficulty lies with the restitution of the authentic chronological order of performance of speech clauses[258]. Sequence markers help to

reconstitute this chronological order. They may be of different types : the very order of the narration itself, linking propositions such as "*and at that point*", "*next*", "*I had not yet* seen the car coming", complements of narration that shed light on the chronology of narrated facts, the result of a clarification probe, the comparison of the meaning of two or more clauses.

Sequence Tags : Once sequence markers have been identified, tags are reference numbers telling 1) in which speech unit and 2) before which other speech clause a given speech clause should come chronologically. Sequence markers and tags are used to elaborate the chronotext.

10.3. Modelling the subject's cognitive processes

This section presents the cognitive modelling techniques used in the Pheno-Cognitive Analysis (PCA) and how they were developed from two initial methodological attempts. The first attempt was based on a semiotic analysis of activity(Théron, 2005). The second one elaborated the foundations of the *cognigraph* cognitive modelling technique in the early moments of this research. Tracing these prior steps constitutes a manner of "memoing"[259] (Creswell, 2007, p. 67), useful to better understand the epistemological assumptions at the root of PCA.

10.3.1. Towards cognitive models of DMA : the chronotext and its verification

The speech clauses discerned during semantic parsing are chronologically reordered into a chronotext. After cleaning up duplicate speech clauses it allows to rewrite the subject's story :

- In a veridical chronological order

- Out of the speech clauses provided by the subject in his narrative.

The following table presents a short extract of Lieutenant A's chronotext :

Speech Unit	NSEQ	Speech Clause #	Speech Clause
02 - It's really serious	1	8-8-ZZZZZ-ZZZZZ	Et puis j'étais toujours au standard
02 - It's really serious	2	8-9-ZZZZZ-ZZZZZ	y'a, y'a--- euh--- (nss) en plus de ce VSAV y'a y'a un engin pompe qui est parti en plus euh--- les les véhicules cinotechniques de <DOGS SPECIALIST STATION> et euh--- euh une ambulance de réanimation.
02 - It's really serious	3	8-10-356-1	oh, eh bien oui, de toute façon, c'est euh, comme j'ai dit aux policiers, j'avais déjà fait des interventions avec des chiens, des chiens mordus, enfin, des gens mordus par des chiens, où nos équipes cinotechniques interviennent et attrapent les chiens
02 - It's really	4	8-10-ZZZZZ-	là peut-être

serious		ZZZZZ	
02 - It's really serious	5	8-11-ZZZZZ-ZZZZZ	Alors

Table 16 Example of chronotext

In this example, we can see that speech clause # 356-1 has been resequenced by the researcher and placed before speech clause # 8-10 as they complement one another to show that the subject remembered his prior experience of dogs bitting victims. “ZZZ” means no resequencing.

It is important to validate this rewritten story with the subject. No further processing of the data can be accomplished before. This validation can also be the occasion for the subject to remember further details and to provide clarifications where needed. When validated, the speech clauses can be semantically analysed and CogOps can be elicited (as certain or assumed).

10.3.2. Activity theory, semiotics and the origins of the cognigraph model

Theureau’s (2004) activity theory and semiotics work provided the methodological bases for the cognitive inquiry into a railway accident (Théron, 2005) for the French Railways (SNCF).

Theureau’s (2004) approach is based on four pillars[260] :

1. A *sign processing unit* called *tetradic sign* by which the individual noticing a sign (“*Object*”) interprets it through an interpreter (“*acquired frame*”), rooted in his experience and his social build, to elaborate an outcome (“*representamen*”) in line with the overall logic of the course of action (“*unity of the course of action*”). “*People act through stories*”, says Theureau (2004), adding that objects that have the highest “*salience*” or “*force*” in one’s consciousness will take precedence in triggering such semiotic reactions.

2. The *transformation of the situation is a succession of sign processing units,* tetradic transformations creating new outcomes that become objects for new tetradic transformations, and action results from that rolling course of semiotic reactions.

3. The primacy of the “*intrinsic*”, which means that rather than investigating behaviours from the outside perspective of an expert it is necessary to look for the “*intrinsic*”, internal, subjective perspective of the individual, his own cognition.

4. A *formal representation* : one of Theureau's contributions to activity analysis is a graphic representation of the succession of triadic[261] signs that underpin human activities to help communicating analyses to other people, first of all to the individual being studied.

In this railway accident three people "helped" to derail a passenger train stationed on a service track of a small station in the West of France. The incident that had taken place in May 2005 was caused by the fact that the passenger train, when ordered to restart its journey, had gone over an armed security device placed on the service track's rail to prevent trains from rolling loose across the express trains track (this device is called "*taquet dérailleur*", derailing peg). The traffic officer, the platform officer and the train driver, though having all taken a part in or having been aware of the removal of that device prior to stationing the train on the service track, all forgot about it when time came to restart the train's journey. The traffic officer did not remember he had manoeuvred it initially and when the train departed from its parking he was in his command post, thinking of what he would do in the evening. Meanwhile, the platform officer was worried that he might be late, only a couple of minutes later, to give the departure to the Paris – Le Havre Express train on platform one and didn't pay attention to the security peg. And the train driver, when given permission to start by the platform officer, thought - as he always used to - that everything was clear ahead, and he departed. Alas, the security peg was still up and the train, rolling on it, derailed. The research question asked by SNCF then was how could all three men, very experienced in their jobs, forget about the derailing peg though they all had gone through its manoeuvring when initially parking the train on the service track ?

This study of "*accidentising*", the process that brought the accident about, was carried out on the basis of interviews of the traffic officer and the platform officer about their own stories of the last couple of minutes that preceded the accident. An interview protocol was designed, using a questionnaire similar to Klein's as reported by Dekker (2002). The answers, plus some complementary free comments and the compilation of a detailed chronogram of the course of events, helped drawing a timelined graph of the semiotic transformation of the situation for each actor. It was based on the semantic analysis of subjects' utterances. Along the timeline the successive *cyclems*, i.e. triplets of (object → interpreter → outcome) labelled (Genotype → Mediator → Phenotype), helped to reveal that each person had *mental stories* competing with one another on her mind during the two minutes preceding the derailment.

The study also indicated that subjects had embarked on intersubjective cognitive courses to reach the decisions they each made. A revised version of the Semiotic Graph approach was applied to the case of Lieutenant A. Théron (2005) had shown that triadic cyclems only represented a chain of cognitive objects, not pairs of {cognitive act ; cognitive object}[262] as in phenomenology. A first "*cognigraph*" (Théron, 2009) was thus elaborated in October 2007, and conceived as a Process Model (OMG, 2011 ; Tardieu et al., 1983 ; Tardieu et al., 1985) of Lieutenant A's cognitive activity[263]. It represented his experience as a sequence of pairs of {cognitive act ; cognitive object}. A semantic analysis of {subject, verb, complement} found in Lieutenant A's narrative revealed an early taxonomy of cognitive acts and objects. After various attempts to produce an easily readable graph, it was decided to represent cognitive acts as coloured pictograms and to represent cognitive objects as column headings on the cognigraph. The idea of using pictograms was derived also from activity theory (Theureau, 2004 ; Amano, 1999, p.193).

This first version evidenced the need to refine the semantic analysis of speech clauses (hence the guidelines provided in this chapter). In contrast with NDM models of cognition, it also showed that there were probably gaps in Lieutenant A's cognitive processes. Beside, the semiotic approach that still influenced our work revealed constraining. Forcing to search for mediators and to designate phenotypes and genotypes arbitrarily, it was giving too much space to interpretation and the composition and validity of triadic cyclems could not be assured. Furthemore, mediators could be formed of several cognitive pairs (grouped inside rectangles on the above *semiotic cognigraph*). The semiotic approach was abandoned.

We kept the principle of the cognigraph with cognitive acts positioned within the columns corresponding to their associated cognitive objects. *Assumed* CogActs pictograms would be striped, instead of plain when CogActs would be *certain*. In Lieutenant A's case, CogActs and their pictograms are as in the following table :

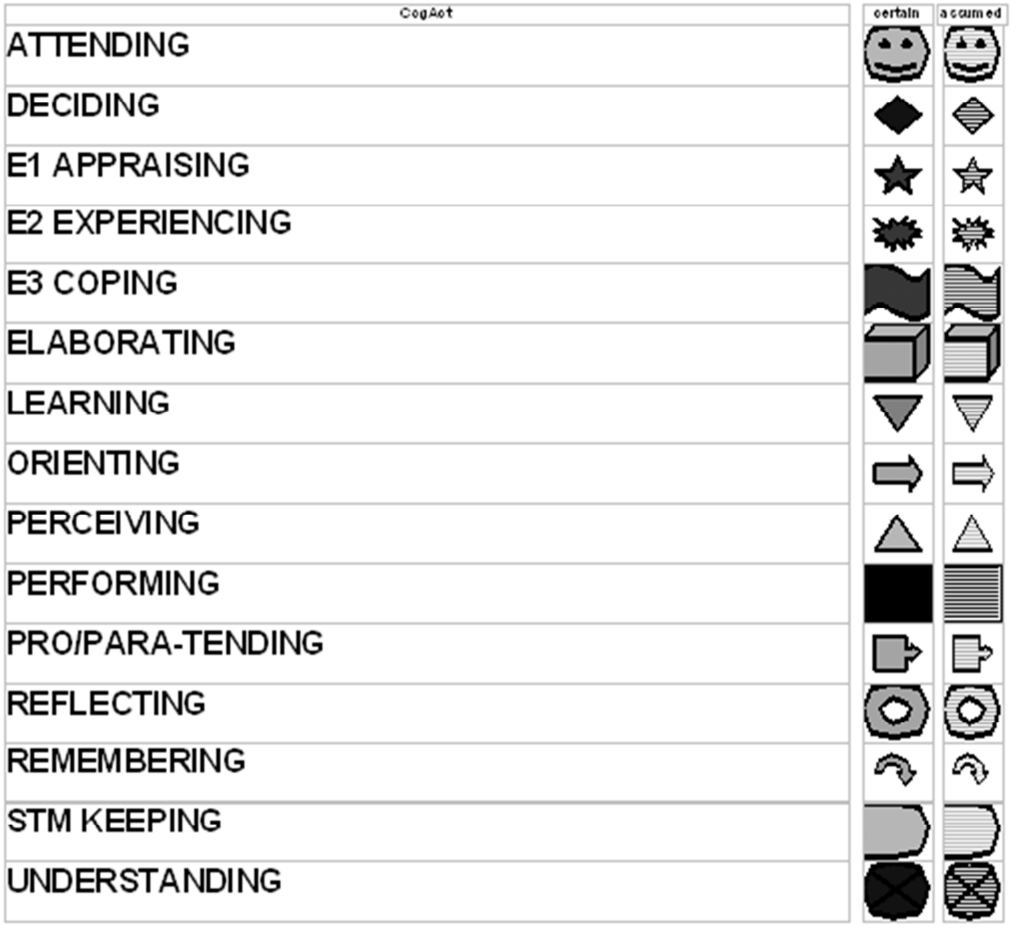


Figure 17 CogActs and their pictograms (for use in cognigraphs)

The definitions elaborated for each CogAct and their higher-order families are :

Family	CogAct	Definition
A01- Learning	LEARNING	= optimising one's ways of cognising and acting
A01- Solliciting Attention & STM	ATTENDING	= pay attention to sthg
	STM KEEPING	= to memorise, keep in mind
A01- Solliciting LTM	REMEMBERING	= cue, seek, retrieve, and bring to consciousness elements from any type of memory
A02- Perceiving	PERCEIVING	= perception, sensation, anticipation
A03- Intuiting / Imagining	PRO/PARA-TENDING	= turning toward the future / anticipating / expecting / imagining
A03- Reasoning	ELABORATING	= consider, tend toward, wish ; a volition, a motivation, an intention, a story, WOA
	ORIENTING	= providing directions for action planning / design
	REFLECTING	= reasoning / reflecting / assuming / believing / being concerned..
	UNDERSTANDING	= perform a synthesis / get a clear, conscious, comprehension & projection of a situation
A04- Emoting	E1 APPRAISING	= being struck by / becoming aware of the presence of a salient stressor(discrepancy / trauma)
	E2 EXPERIENCING	= a traumatism, an Emotion / Stress, a Mood, ie a Pressure from the COE
	E3 COPING	= choose / elect a style / way of coping
A05- Deciding	DECIDING	= consciously selecting a pragmatic option
A06- Acting	PERFORMING	= an act in the world = to do, make, search, seek, move, interact, speak, express, freeze, ...

Table 17 Types and definition of CogActs

The following table presents the different CogObjs also identified in this research, their name, a definition, and the higher order family in which they were grouped :

Familiy	CogObj	Definition
00- LTM objects	ENCYCLOPAEDIA	The subject's memory : What has been learnt theoretically or through practice
	PERSONALITY	The subject's personality traits
01- Metacognitive objects	COGNITIVE PROCESS	The subject's own cognitive process as object of his cognitive experience
02- Attention Objects	ATTENTIONAL OBJECTS	The subject's direction / tension of consciousness toward objects of cognition.
03- Affective objects	A1 SHOCK / SALIENCE	The emergence of a striking phenomenon in the subject's consciousness
	A2 AFFECTS	The subject's emotional reaction to the experience of a sudden salience in his consciousness
	A3 COPING MODE	The subject's tendency to react in one way rather than another
04- Cognitive objects	REFLECTIONS	The subject's thoughts
05- Situational objects	SITUATION - COE / COA[264]	Situation : An understanding, Picture, Mental Story, Explanation
06- Action Regulator objects	ABILITIES	The subject's inner capacity to act upon the situation : Knowledge, strength…
	ACTION PLAN	The potential ways the subject seeks to inflect the course of events
	CONFIDENCE	The subject's sense or understanding of probability, confidence, trust
	LATITUDE - MARGINS	The margins of manoeuvre experienced / appraised by the subject at the time of action, that allows him or not to engage into options for action, and such as: Space, Time, Safety, Freedom, Social support, Legal rights…
	STIMULATIONS	Intention / Motivation, a Goal, Priority, Order…
07- WOA Experience objects	OBJECTS	Material / Inanimate things / artefacts in the subject's World Of Activity
	OTHERS / ANIMALS	Other people or animals in the subject's World Of Activity
	SETTINGS	Texture or Sense of space
	SOCIAL AMBIENCE	Sense of social ambience
	TIME	Texture / Sense / Perception of time
	WE	The group in which the subject belongs
08- Actions taken	SELF	The subject as actor in the world and object of cognition

Table 18 Types and definitions of CogObjs

10.3.3. Cognitive models of DMA : the cognigraph (elaboration and verification)

When cognitive operations have been elicited from the semantic analysis of speech clauses[265] they can be processed in several steps :

1. Present Moments (PM) appear : in the total sequence of cognitive operations[266] the researcher can delimit them by detecting first “actions” and then, going backward in the sequence of CogOps, by trying to detect the corresponding triggering CogOp, a perception or remembrance cognitive activities for instance. Itself, except for the very first one in the sequence (usually an action), is preceded by another “action”, which marks the end of the previous PM. Each PM is numbered in sequence and given a short descriptive title in order to allow a quick reading through of the entire story. Within each PM, CogOps are numbered in a sequence relative to the PM : CogOps are numbered from 1 to n in each PM. So that a CogOp is uniquely identified by the concatenation of both numbers : 1-1, 1-2, 2-3, etc.

2. A verification of the encoding and chronological sequence of the CogOps forming each PM is required. This is accomplished through a patient process of iterative checks between the speech clauses in the resequenced narrative and the list of CogOps derived

from each speech clause. At this stage, encoding and sequencing errors can be detected : wrong category of CogActST[267] or CogObjST in correspondence to a speech clause[268], wrong status of a CogAct (certain vs. assumed), missing CogOps that should have been elicited or assumed, wrong sequence between CogOps, absence of an action between what the researcher considers as two distinct PMs.

3. The cognigraph of each PM should be drawn at this stage. The visual verification of the cognigraph of a PM helps the researcher to check the composition of the PM. The pattern of its cognitive trajectory is revealed at this stage. The researcher can see how types of cognitive operations follow one another and check each trajectory against competing cognitive models (such as the RPD model for instance). Proceeding further with data processing requires that these verifications have been made.

A cognigraph is presented in lines and columns.

Each line corresponds to a CogOp along the timeline.

The CogOp is a {CogAct ; CogObj} pair. On each line, the symbol of the CogAct composing the CogOp is displayed under the column corresponding to its associated CogObj.

A cognigraph looks as follows (cognigraph automatically generated by the phenomenographic database), here for PM # 10 in Lieutenant A’s case (column headings are drawn from table 18 above, and raws’ headings are drawn from table 17) :

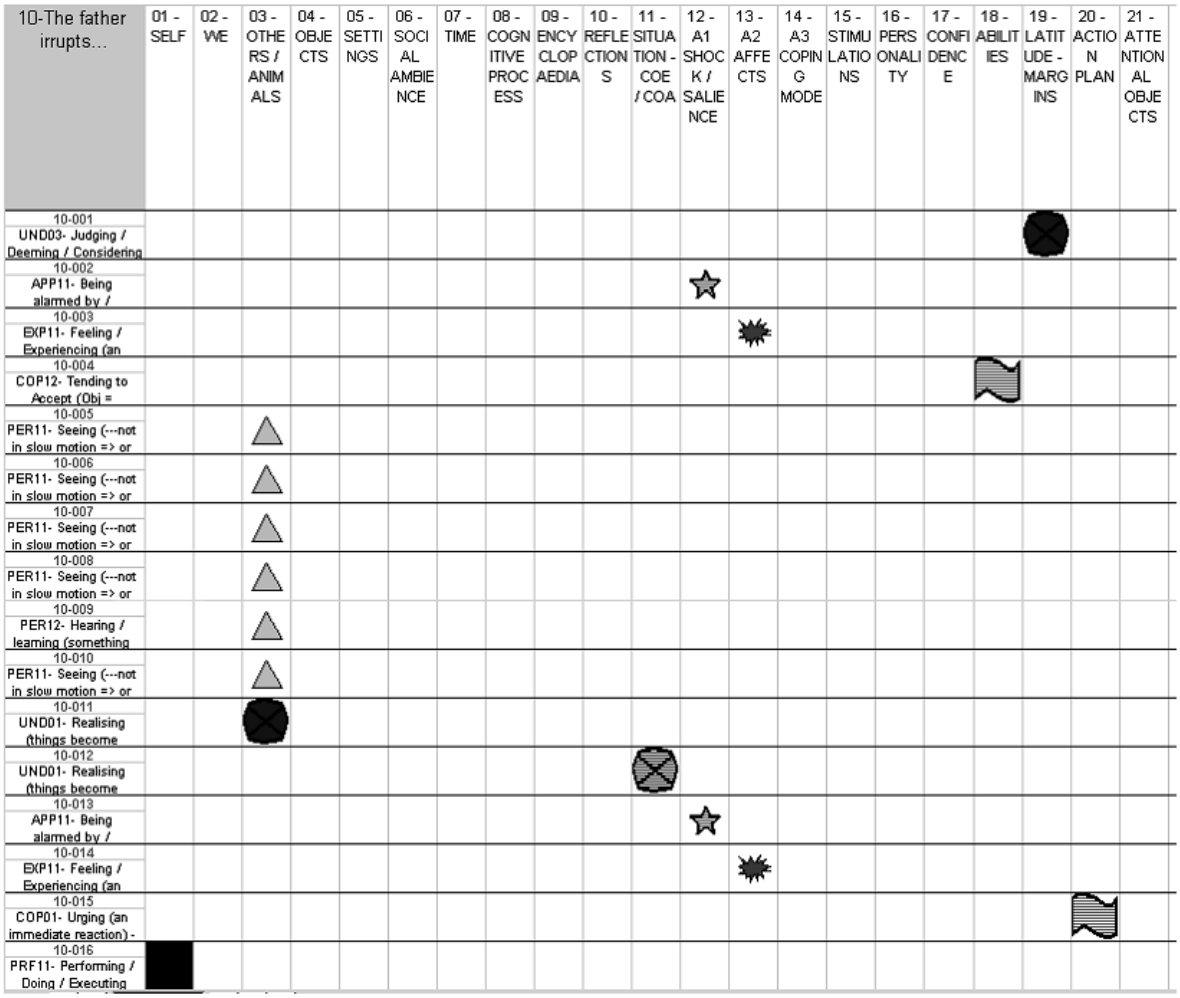


Figure 18 Lieutenant A's cognigraph at the "Pre-CI Tension" Experience Phase (PM #10)

10.3.4. Cognitive models of DMA : decision networks

The calculation of a decision network creates a more meaningful picture of the subject's cognitive activity than a cognigraph.

The fairly high number (460) of CogOps permited to calculate the genotypic and phenotypic shapes of cognitive trajectories at any level of analysis of the subject's experience : his entire story (global level), a CI Experience Phase (intermediate level), a Present Moment (detailed level).

"*Genotypic shape*" refers to the summed frequencies of each series of *posterior* → *anterior* links between CogOps. The calculation of these links produced what was called "*Anteriority Networks*". For instance, at the Pre-CI Tension phase, the following table of genotypic links was calculated :

PHENOTYPIC COGOP	FREQ OF GENOTYPIC LINK →	PRECEDED BY GENOTYPIC COGOP
E1 APPRAISING - A1 SHOCK / SALIENCE	50,00%	UNDERSTANDING - LATITUDE - MARGINS
E1 APPRAISING - A1 SHOCK / SALIENCE	50,00%	UNDERSTANDING - SITUATION - COE / COA
E2 EXPERIENCING - A2 AFFECTS	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
E3 COPING – ABILITIES	100,00%	E2 EXPERIENCING - A2 AFFECTS
E3 COPING – ACTION PLAN	100,00%	E2 EXPERIENCING - A2 AFFECTS
PERCEIVING – OTHERS / ANIMALS	83,33%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	16,67%	E3 COPING - ABILITIES
PERFORMING - SELF	100,00%	E3 COPING - ACTION PLAN
UNDERSTANDING - OTHERS / ANIMALS	100,00%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	100,00%	UNDERSTANDING - OTHERS / ANIMALS

Table 19 Table of genotypic links for the "Pre-CI Tension" CI Experience Phase

"*Phenotypic shape*" refers to the summed frequencies of each series of *anterior* → *posterior* links between CogOps. The calculation of these links produced "*Decision Networks*". The following table of phenotypic links was calculated for the same Pre-CI Tension phase :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC LINK →	FOLLOWED BY PHENOTYPIC COGOP
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	50,00%	E3 COPING - ABILITIES
E2 EXPERIENCING - A2 AFFECTS	50,00%	E3 COPING - ACTION PLAN
E3 COPING - ABILITIES	100,00%	PERCEIVING - OTHERS / ANIMALS
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
PERCEIVING - OTHERS / ANIMALS	83,33%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	16,67%	UNDERSTANDING - OTHERS / ANIMALS
UNDERSTANDING - LATITUDE - MARGINS	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - OTHERS / ANIMALS	100,00%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE

Table 20 Table of phenotypic links for the "Pre-CI Tension" CI Experience Phase

The Decision Network of the same "Pre-CI Tension" CI Experience Phase looks as follows:

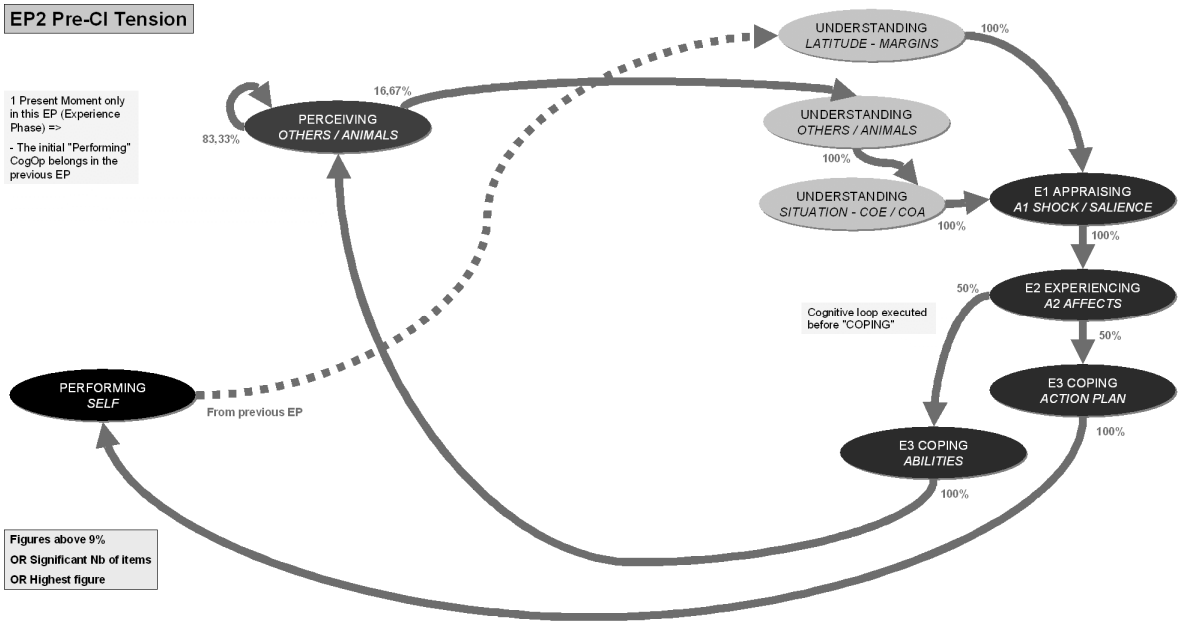


Figure 19 Lieutenant A's Decision Network at the "Pre-CI Tension" CI Experience Phase

Each oval represents a CogOp, and arrows represent phenotypic links. Summed frequencies are indicated at their origin. As each Present Moment (PM) starts after the last ACTION[269] (represented by the "Performing – Self" CogOp) sparked by the previous Present Moment, Decision Network graphs show as a bold doted arrow the phenotypic link between the previous PM's ending ACTION and the first CogOp performed in the PM (this indication is supplied by the PM's corresponding cognigraph). Decision Networks of the global and intermediate levels of analysis[270] present the *driving* cognitive trajectory (boldest links = most frequent), and *alternative* cognitive trajectories (second boldest links = less frequent trajectories). Narrow arrows indicate infrequent links. Decision Networks at the PM detailed level of analysis do not distinguish driving trajectories from alternative trajectories as there is only one trajectory within a given PM. Decision networks show, when easily representable, the *cognitive loops* performed in the course of cognitive trajectories. Cognitive loops are "sub-trajectories", sub-processes that the subject seems to accomplish in order to support either Situation Awareness or Action Selection within a Present Moment. They may be triggered by factors of bifurcation noted by Klein's (1998)[271] : the a-typicality of the situation pattern, the need to find a more efficient plan, etc.

Decision networks can be drawn for the detailed level of Present Moments (PM). The decision network for PM # 2 looks as follows (data are extracted from the phenomenographic database) :

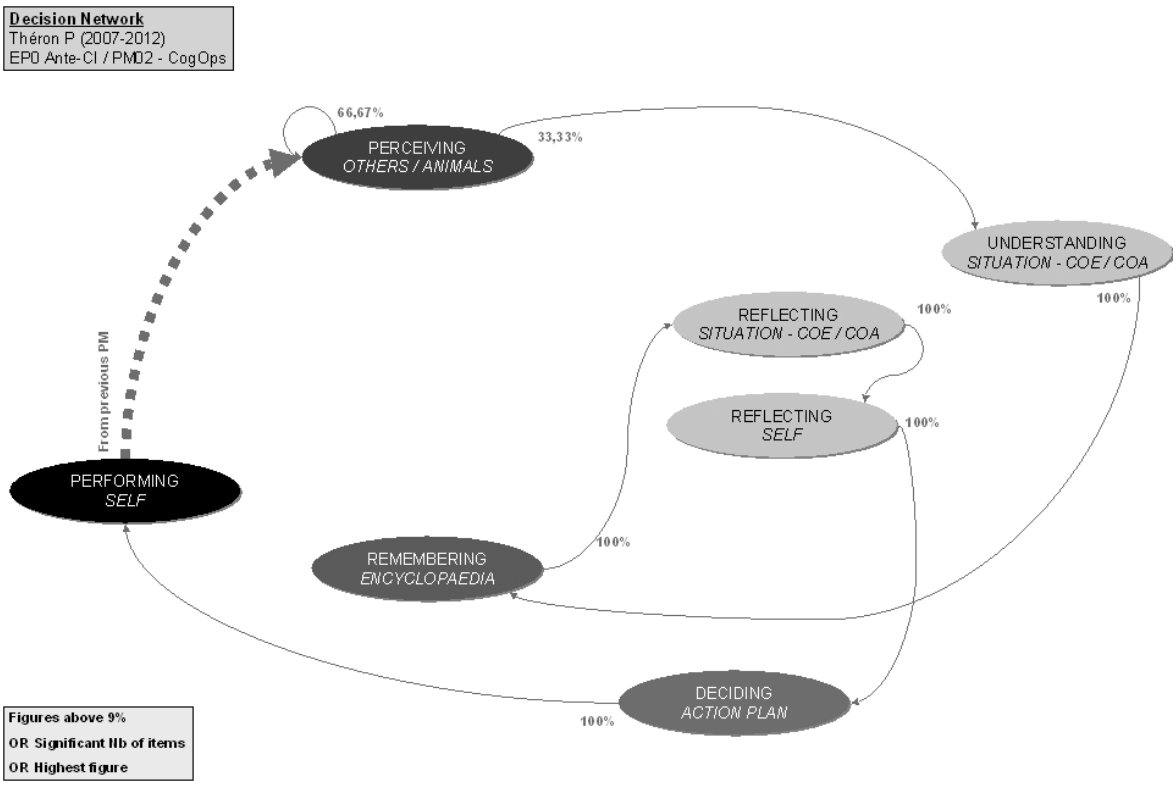


Figure 20 Decision network of PM # 2 in Lieutenant A's case (based on CogOps)

Decision networks provide a synthetic view of cognitive trajectories whereas cognigraphs present the actual complete sequence of CogOps performed during a PM. In Zachary et al.'s (2001) terms, cognigraphs and decision networks are individual, descriptive *critical decision models* i.e. "*Domain-specific models that capture and represent the logic and situational relationships that underlie decision making in that specific domain*" and represent it in "*a combined prose / graphical notation.*". The calculation of Decision Networks at the level of sub-types of CogAct and CogObj, i.e. of {CogActST ; CogObjST} pairs, was also attempted but it yielded such a variety of cognitive trajectories that in fact it did not anymore reveal any cognitive pattern of the DMA process. Therefore it was decided to keep on the {CogAct ; CogObj} level. Finally, Anteriority Networks did not add any significant epistemological value and the choice was made to analyse only Decision Networks. This choice is also consistent with current NDM modelling approaches.

10.3.5. Decision-making steps : drawing a more readable global decision network

When drawn for the global level of the entire episode of experience, decision networks become too detailed and hard to read if based on cognitive operations i.e. pairs of {CogAct ; CogObj}, and even more if based on pairs of {CogActST ; CogObjST} sub-types.

Beside, the denominations of a CogOp or of a CogOpST does not match the vocabulary commonly used in NDM studies to name the *cognitive steps / functions* of the decision-making cycle. Finally, if we consider that this latter *cognitive step* is an attribute in a context of data processing, using CogOps and CogOpSTs creates too many categories for this attribute.

On the basis of the NDM analytic framework summarised in the conclusions of chapter 4, each CogOp can be substituted a *DM Step* (Decision Making Step). DM steps are a higher level of abstraction of CogOps. The following taxonomy of DM Steps, indicating the correspondence with the CogOps they substitute, was elaborated :

DM domain/family	DM Steps	CogOps corresponding to DM Steps
0- Attention & STM	DM01- Attention & STM	ATTENDING - ATTENTIONAL OBJECTS
		ATTENDING - LATITUDE - MARGINS
		ATTENDING - OTHERS / ANIMALS
		ATTENDING - SELF
		STM KEEPING - OBJECTS
		STM KEEPING - OTHERS / ANIMALS
		STM KEEPING - SETTINGS
		STM KEEPING - SITUATION - COE / COA
		STM KEEPING - STIMULATIONS
1- Metacognition	DM02- Metacognition	LEARNING - ENCYCLOPAEDIA
		LEARNING - PERSONALITY
2- LTM	DM03- LTM	REMEMBERING - ENCYCLOPAEDIA
		REMEMBERING - OBJECTS
3- Perception	DM10- Acquisition	PERCEIVING - OBJECTS
		PERCEIVING - OTHERS / ANIMALS
		PERCEIVING - SELF
		PERCEIVING - SETTINGS
4- Interpretation	DM21- Analysis	REFLECTING - ACTION PLAN
		REFLECTING - ATTENTIONAL OBJECTS
		REFLECTING - LATITUDE - MARGINS
		REFLECTING - OTHERS / ANIMALS
		REFLECTING - REFLECTIONS
		REFLECTING - SETTINGS
		REFLECTING - SITUATION - COE / COA
	DM22- Anticipation (SA)	PRO/PARA-TENDING - SITUATION - COE / COA
		REFLECTING - SITUATION - COE / COA
	DM27- Judgement	UNDERSTANDING - CONFIDENCE
		UNDERSTANDING - ENCYCLOPAEDIA
		UNDERSTANDING - LATITUDE - MARGINS
		UNDERSTANDING - OTHERS / ANIMALS
		UNDERSTANDING - SITUATION - COE / COA
		UNDERSTANDING - STIMULATIONS
		UNDERSTANDING - TIME
5- Affect Coping	DM31- Appraisal	E1 APPRAISING - A1 SHOCK / SALIENCE
	DM32- Affection / Shock	E2 EXPERIENCING - A2 AFFECTS
	DM33- Coping	E3 COPING - ABILITIES
		E3 COPING - ACTION PLAN
		E3 COPING - OBJECTS
		E3 COPING - OTHERS / ANIMALS
		E3 COPING - SELF
		E3 COPING - SETTINGS
6- Planning	DM42- Stimulation (Motivation / Intention)	ELABORATING - STIMULATIONS
		ORIENTING - OTHERS / ANIMALS
		ORIENTING - SELF
		ORIENTING - SITUATION - COE / COA

		ORIENTING - STIMULATIONS
	DM44- Orientation (Action Design)	ELABORATING - ACTION PLAN
		ELABORATING - STIMULATIONS
		REFLECTING - ACTION PLAN
	DM48- Checking (consistency / applicability / efficiency / outcome)	ORIENTING - SELF
		REFLECTING - ACTION PLAN
7- Decision	DM50- Selection	DECIDING - ACTION PLAN
8- Action	DM60- Action	PERFORMING - SELF

Table 21 Taxonomy of DM Steps and correspondence with CogOps

DM steps are numbered as shown above to signify that they could be grouped into higher-level generic (macrocognitive) decision-making functions. The first of the two digits represents these macrocognitive functions : 0 represents *support functions*, 1 corresponds to *perception*, 2 to Endsley's concept of *situation awareness*, 3 to Lazarus' concept of *affect coping*, 4 to *planning the course of action*, 5 to the *choice* (decision) of the course of action, and 6 to *action* in the physical world. *DM Domain* corresponds to more abstract groups in which DM steps were grouped (their number is not significant). The second digit of DM Steps code evokes a *possible* rank or sequence of execution within each generic step. ANNEX 12 shows the more detailed correspondence between DM Steps and CogOp subtypes.

At this stage, the researcher has processed the data extracted from the subject's first-person narrative and can start data analysis.

10.4. The Phenomenographic database

The constitution of a ***phenomenographic database*** was undertaken to support data processing and to ensure the traceability of the entire process. It was elaborated during the study of Lieutenant A's case and is now an advanced prototype. This development helped to model the process of the phenomenography. Without the phenomenographic database, a PCA research would be much more fastidious.

The Phenomenographic database relies upon a relational database. Its model reflects, like all such models, the functional and non-functional requirements and choices[272] made in the present research :

- All the data handled for the study of Lieutenant A's case had to be managed in the database : primary data (the transcript of the Elicitation Interview, its question & answer structure) as well as secondary data created to prepare the analysis : the speech clauses parsed from each answer, identified cognitive operations with their pairs of {act

; object}, Present Moments, characteristics / variables describing the context or each cognitive operation or Present Moment, the phases of the experience of trauma, DM Steps, …).

- It had to allow the generation of multiple versions of the chronotext should analytical doubts lead to chronological variants of the reconstituted story.

- It had to allow to bring changes in the associations of speech clauses, with story segments for instance, as the phenomenography was in progress.

- It had to allow to record the assumptions made about the existence or the sequence of cognitive operations.

- It had to be easy to use as far as a prototype can be.

- It had to assure the traceability of the analysis, from the narrative's speech clauses to outcoming data sets used for exploratory factor analyses.

- It had to automate data processing as far as would be feasible, and beyond to allow to export data sets from the database for their reuse in other pieces of software (for exploratory factor analyses).

ANNEX 4 provides an overview of the classes of data that were implemented.

As it is, the Phenomenographic database is still a prototype. Its functions were progressively developed and successive refinements were made as taxonomies, definitions, constraints, needs and data processing possibilities emerged. It cannot yet be considered operational for reuse by other researchers and its further development is one of our folllow-up projects. Its main functions are :

- EI Transcript entry

- Initial parsing of the EI transcript (into Speech Clauses and Speech Units)

- Chronological resequencing of speech clauses (Chronotext)

- Cognitive taxonomy (CogActs and CogObjs forming CogOps, and their sub-types)

- Cognitive Operations sequencing and sequence checks
- Integrity Checks
- Present Moments identification and demarcation
- Cognigraph generation (global, per PM, per CI experience phase)
- Identification of generic Decision-Making Steps (DM steps)
- Genotypic analyses (Precedence links between CogOps or DM Steps)
- Phenotypic analyses (Subsequence links between CogOps or DM Steps)
- PM and CogOp attributes and basic statistics and categorical analysis functions
- Data queries and exports
- Results printing
- Notes recording
- Data Management (parameters)
- Utilities (development functions, windowing).

CHAPTER 11. Methods of data analysis, discussion and conclusions

11.1. Data analysis

Data analysis aims at producing findings out of the material elaborated by data processing. This includes :

1. The categorisation of the various patterns of cognitive trajectories (*DMA*[273] *patterns*) and their description at the different levels of the structure of an episode of cognitive experience (episode, Present Moments, and any other intermediary sub-episode levels identified by the researcher). This analysis stems from decision networks and cognigraphs.

2. The identification and analysis of their variations (if any) and the search of the factors of such variations. There are two potential levels of analysis :

    - Variations of pattern from one PM to the next, and across all PMs during the entire episode : this is called *inter-variation* analysis. The number of PMs in an episode is relatively small (44 in Lieutenant A's case) and the data sets that can be elaborated are therefore fairly small. The analysis can be performed through :

        - The search and definition of PM characteristics (attributes and their categories or values). This part of the analysis can be based either on inputs from existing literature or on a process of iterative interpretation of the material on hand

        - The exploration of data through a *categorical analysis* (Mendenhall et al., 2003) and *exploratory factor analysis* (EFA), to look for associations between attributes (Upton & Cook, 2006). This can include various forms of scatter plotting, regression coefficients, principal component analysis, or else Pearson's correlation coefficient when analysing continuous attributes, and the Chi-square test, Goodman & Kruskal's (1979) asymmetric lambda[274], Cramér's (1946) *v* or bayesian networks when analysing categorical (nominal) attributes.

    - Variations within patterns, called *intra-variation* analysis. In a case study a few patterns can be discerned. The number of CogOps performed during an episode is important (460 in Lieutenant A's case). The analysis can be performed through an *exploratory factor analysis* (EFA) of the corresponding data set.

3. The identification and analysis of possible *phases* in the individual experience of a Critical Incident. The process of this analysis is qualitative – interpretative.

4. The analysis of *peritraumatic resilience* (PTR). It consists in searching for Present Moments during which PTR is displayed by the subject, for its factors, for coping strategies, and for relations between PTR and the cognitive process of DMA. This can be done through interpretative and categorical analyses.

5. The elaboration of *cognitive models* of DMA and PTR. Once elaborated, models should be tested against the data of the case and compared to similar models found in the relevant scientific literature. The ambition of the data analysis stage in a PCA study is to perform a trustworthy restitution of the reasoning model (Zachary et al., 2001) of the subject and to validate this model against actual outcomes (actions) identified in cognigraphs, which is a limited form of *predictive validation* (Zachary et al., 2001). As there is not a unique way to model cognition in action, two techniques have been employed in the study of Lieutenant A's case : *production rules* and *bayesian networks*. For Zachary et al. (2001), production rules are "*abstracted representations of atomic if/then propositions*", "*typically used in expert systems*." (p. 217). Bayesian networks are "*mathematical and computational methods to permit reasoning about uncertainty based on the underpinning of Bayes rule (that the probabilities of all disjoint events sum to unity).*" (ibid, p.217). This completes the analysis before the discussion.

General findings should be summarised at the beginning of the data analysis part of the report.

NB : These recommendations correspond to the goals of the present research. Other findings could be sought in relation to other research goals : for instance to studying mental models, mental stories at work, collaborative cognition, etc.

11.2. Discussion : the topical and the epistemological perspectives

Discussion is the phase of a Pheno-Cognitive study that allows the researcher to interpret the findings of the analysis from two perspectives :

- A *topical perspective* : for instance this study focuses mainly on metacognitive training that can prepare for, or protect from potential CIs fire-fighters and other people

exposed to dangerous work conditions. Other perspectives can emerge in the course of the discussion as this is an open process.

- An *epistemological perspective* : the validity and efficacy of the PCA Framework, for instance, and depending on the fact these issues have already been debated or not in the body of the report :
    - The epistemological value of a PCA study
    - The scientificity of the data collection process, the Elicitation Interview (EI)
    - Data processing and its choices
    - The attributes with which data analyses are performed
    - The data analysis process (interpretative aspects, factor analyses, …)
    - The way cognitive models derived from an idiographic study can be validated, first against the case's data, secondly against competing / existent models…

11.3. Epistemological considerations

This chapter explains the principles of scientificity in this context.

11.3.1. Discussion as reflection on the scientificity of a PCA study

The epistemological discussion should, when needed, bear on the precautions taken in the performance of the Elicitation Interview (EI) and the verifications made along the data processing tasks as part of the measures to take in order to ensure the scientificity of a PCA study.

11.3.2. Five minimal conditions of scientificity of a PCA study

At least five conditions should be met to ensure the scientificity of a PCA study :

- The veridicality of phenomenological memories evoked in the Elicitation Interview
- The quality of the narrative

- The reliability of the phenomenography (data processing)
- The ecological validity of the analysis
- The traceability of the process.

11.3.3. Further views on the veridicality of phenomenological memories

Cho & Trent (2006) say that "*Reminiscent of the paradigm wars, qualitative research, validity safeguards included, is the object of intense scrutiny and critique*.". They provide doctrinaire examples of this segregation between good and poor science : "*In the USA […] The No Child Left Behind Act of 2001 calls for 'scientifically based research' and defines this as 'the application of rigorous, systematic, and objective procedures to get reliable and valid knowledge. The research … must employ rigorous data analysis to test the stated hypothesis … The definition includes the expectation that the studies are replicable' (AACTE, 2002: 2; NRC, 2002). […and] the US Department of Education's Strategic Plan 2002–2007 supports only 'studies that are backed by 'qualified scientists,' that 'address causal questions,' and that employ 'randomized experimental designs*.'" (pp. 319-320).

Phenomenology, "*step by step, attempts to eliminate everything that represents a prejudgement, setting aside presuppositions*", says Moustakas (1994, p. 41). In his view, it is a science because "*it affords knowledge that has effectively disposed of all the elements that could render its grasp 'contingent'*"(ibid, p. 45). Three points should be raised in relation to scientificity in the context of a PCA study :

1. The hermeneutical objection
2. The "embodiment" and "situatedness" of the cognitive experience
3. The risk of inaccuracy in phenomenological recollections (Conway, 1995) :
    - The "*fantasy/memory complex*"
    - Repression
    - Memory sins.

11.3.4. The hermeneutical objection and the way forward

The validity of a research based upon narratives is essentially a transactional trade-off between the researcher's inquiry paradigm (Cho & Trent, 2006) and the subject's motivations (Edwards & Potter, 1992).

The "*hermeneutical objection*" to phenomenological studies, say Varela & Shear (1999), is that "*the deeper experience is always enfolded in language and hence a new account can only be an inflexion of linguistic practices*" (pp. 13-14). Hence an impossibility to collect memories of the authentic cognitive experience of the subject. The "*descriptions we can produce through first-person methods are not pure, solid 'facts' but potentially valid intersubjective items of knowledge, quasi-objects of a mental sort. No more, no less.*" (ibid, p. 14).

In the context of non-phenomenological, episodic-memory-loosely-guided interviews such as the John Dean's testimony to the senate 'Watergate' committee and similar verbal reports, Edwards & Potter (1992) argue that the interviewee's account of a past event can only be a socially circumstantial motivated reconstruction of the authentic facts.

Such views are supported by Gardner (2001) and researchers in Memory studies (Conway, 1995 ; Barclay, 1995). But as Gergen (1994) states, it might be only a matter of dispute between psychologists on one hand who see cognition behind narratives, and "textual essentialists" (ibid, p. 80) for whom "*what can be said about one's past and how it can be made intelligible are fashioned by the rhetorical conventions of the time*" (ibid).

Cho & Trent (2006) define "*transactional validity in qualitative research as an interactive process between the researcher, the researched, and the collected data that is aimed at achieving a relatively higher level of accuracy and consensus by means of revisiting facts, feelings, experiences, and values or beliefs collected and interpreted.*" (p. 321).

Bartlett (1932, p. 296) adds that in a "*social constructionist view*" a "*social organization gives a persistent framework into which all detailed recall must fit, and it very powerfully influences both the manner and matter of the recall*" (ibid, p. 90).

Conway (1995) assumes the "*veridicality*" of autobiographical memories, "*autobiographical knowledge [being] an accurate but incomplete record*" (p. 88). Only, the researcher must be attentive to eliminate from the subject's account anything that

resembles a retrospective interpretation of his experience at large (Vermersch, 2006), which each individual necessarily produces in the construction of his own Self (Husserl, 1977, p. 161 ; Barclay, 1995).

Rosat (2008), quoting the late works of Wittgenstein[275], states that "*there is no language nor concepts that would be more directly related to the feeling of pain than the physical expression of pain itself – expression of the body in screaming or faces -, and also the verbal expression of pain, the utterance "I hurt" that adds or substitutes to the physical expression*"[276] (p. 15). He adds that "*in order to identify our experiences – to recognise them, to name them, to distinguish them from one another – we describe them by way of a verbal expression that is that of a comparison, and therefore of an interpretation*" (ibid, p. 16) and that the "*words of the interpretation*"[277] describe our experience. Our utterances are the most direct way we have to report our inner experience. The reality of our inner experience would then be little interpreted through elements of language. Language does not disable the possibility of a phenomenological narration. But for Matthews & Chu (1997) the subject's "*capacity for language*" may be determinant.

Finally, the expressions of the subject, both verbal and non-verbal, and their "style", his grammar in Wittgensteinian formulation, help the analyst to explicit the actual nature of the subject's experience. This point highlights the importance of a good knowledge of the subject's milieu, hence of an immersion prior to Elicitation Interviews.

The hermeneutical bias is assumed in this thesis to be a moderate problem under the following conditions :

- Elicitation Interviews must be performed strictly according to the guidelines provided here and by Vermersch (2006) : its main principle is to systematically induce and guide the recall of authentic elements of cognition from the subject's episodic memory.

- The researcher should proceed to a preparatory immersion in the field of his research prior to performing EIs in order to understand the subtleties of the narration and be able to better guide the subject's recall and narration.

- Other forms of first-person interviews are not applicable in a PCA study : unguided self reports, inquiry interviews, cognitive interviews, psychiatric interviews, etc…

11.3.5. The "embodiment" and "situatedness" of the cognitive experience

The notion of *veridicality* rejoins the concept of *embodiment* highlighted by all researchers in phenomenological psychology. Embodiment can be understood as the rooting of all human experience in one's body. Ginsburg (1999) explains that "*We speak of consciousness as a state. Yet everything we know in consciousness is connected to movement. In order to see the book on the table across the room I must make an act of attention. I turn my head and eyes and focus at the distance*." (p. 79). Experimental Psychology (Zimmer & Cohen, 2001, pp. 9-10) "*demonstrated a clear memory advantage of performing the actions*". The subject-performed task (SPT) effect is that in laboratory settings we keep a better memory of the actions we have physically performed than of actions we have only imagined. The embodiment of experience contributes to the encoding in episodic memory of certain elements of its "texture" (Conway, 1995)[278].

Beside being situated in our body, our experience is *situated* in our world of activity. Conway (1995) stresses that our autobiographical memories are full of "*microdetails*" associated with salient micro events emerging in the course of the lived experience : "*turn taking in conversation, perhaps a number of different topics were covered, possibly people left and joined the group during the discussion, and so on*" (p. 70).

The situatedness and embodiment of the Present Moment reinforce our autobiographical memories : events are encoded along with the "*texture*" (Moustakas, 1994) of experience. For Koutstaal & Schacter (1997) "*Whereas memories for perceived events generally contain many perceptual details (e.g. sound, color, contextual information (details concerning time and place, and semantic information, memories originating in one's thinking or imagination tend to have relatively less information of these forms and more information about an individual's internal cognitive environment at the time of the event, such as why or when one happened to notice certain things*." (pp. 112-113).

The present research studies a given, delimited, situated, embodied and enacted episodes of experience. It presents the above mentioned characteristics.

11.3.6. The risk of inaccuracy in phenomenological recollections

Barclay (1995) stresses the risk of inaccuracy of the *public* reconstruction of *personal* memories, "*built on fragments of information [that] require inferences in order to fill in the gaps until there is a 'narrative fit'*" (p. 100). If what is in discussion in his work is the study of memory in laboratory settings, based on well known protocols : free recall, cued

recall or recognition, and the use of lists of words[279], some factors may endanger the veridicality, the "*truthfulness to the original experience*" of phenomenological narratives :

- The "*fantasy/memory complex*" (Matthews & Chu, 1997)
- Repression (Elin, 1997 ; Kluft, 1995)
- Memory sins (Schacter & Dodson, 2001 ; Brewer, 1995).

11.3.6.1. The "fantasy/memory complex"

Interesting lessons have been learned from early childhood abuse studies. Subjects affected by traumatic experiences may develop, especially if those experiences are repeated at an early age (Matthews & Chu, 1997), a "*subjective memory*" of those past events, i.e. fabricated memories "*created under the synergistic pressures from external influences (family[280]) and internal needs to deny the horrible truth*" (ibid), mixing "*objective reality, personal meanings, and fantasies […] unconscious interpretations […] and associated feelings (such as guilt)*" (ibid).

The hypothesis is that autobiographical memories of traumatic experiences might be augmented, in the course of the constitution of one's personality, of "*added meanings*" (Kris, 1956), progressively "*added into the structure of the personality*" (ibid). Psychological trauma "*is an affliction of the powerless*" (Herman, 1992)[281], and "*The child who is living in an abusive situation is captive to the experience [… and] faced with overwhelming traumatic experience and the failure of external supports […he] has powerful motives to deny, distort, or rationalize the traumatic events in order to maintain needed emotional ties, and to reduce the feelings of helplesness*" (Matthews & Chu, 1997). Matthews & Chu (1997) remind the "*schematic function of memory*", i.e. "*the formation of 'schemata' or 'scripts' that represent and synthesize past experience, organize the perception of current experience, and are constantly revised by the assimilation of new information […] and are modified through both conscious and unconscious processes to serve the needs of coherence, defense, and adaptation*".

Therefore, "*the internal representation of actual traumatic experience will always contain (in varying degrees) elements of fantasy*" (ibid). On another hand, "*the external trauma makes actual the most feared or dangerous fantasies, replacing the fantasy with a horrible reality*" (ibid).

But memories of the experience of trauma are hardly alterable with the passage of time says Van der Kolk (1997) : "*the excessive arousal at the moment of the trauma interferes with the effective memory processing of the experience [] the resulting speechless terror [leaving] memory traces that may remain unmodified by the passage of time, and by further experience*".

When a long time has elapsed it may happen that people who suffer traumatism "*reach a position where they have resolved the internal doubts, are realistically confident of their own histories, have an understanding of the associated fantasies and conflicts, and accept the limits of absolute knowledge […] and can speak of the abuse memories as a part of the past [and] the memories are well integrated into the self and world schemas, and can be referred to as part of the shared understanding of the patient's life story*" Matthews & Chu's (1997) experience.

In the case of Lieutenant A, his memories were still fresh and vivid : the incident had taken place only one month before the Elicitation Interview. As indicated in the EI guidelines, we were attentive to[282] "*listen to the subject's internal reality*", and to a possible "*reconstruction*" (Matthews & Chu, 1997) of his experience. Contextual priming and probing guided the subject into an evocative stance, and the impact of the "*fantasy/memory complex*" should be minimal.

11.3.6.2. Repression as an obstacle to the narration of traumatic episodes

The attempt to collect episodic memories of traumatic events could be jeopardised by *repression*, a "*defense of the psyche*" (Elin, 1997, p. 216), a process "*by which the defensive exclusion of autobiographical experience from available and routinely retrievable memory*" (Kluft, 1995, p. 25) is performed, a "*horizontal splitting*" (Matthews & Chu, 1997) "*in which certain psychic experiences [something that is once 'known' (consciously experienced)* and *becomes unavailable to consciousness] are actively barred from conscious awareness*". The traumatic event may become forgotten by subjects who suffered it.

This was not the case with Lieutenant A.

11.3.6.3. Memory sins

Memory errors have been extensively studied, for instance by Brewer (1995), or Schacter & Dodson (2001) who remind that "*Memory is a troublemaker*" prompt to a number of "*transgressions [classified] into seven 'fundamental' sins : transience, absent-mindedness, blocking, misattribution, suggestibility, bias and persistence*" (pp. 71-72). But there is probably a lesser chance that memory be affected by these *transgressions* if they relate to *embodied* pieces of life experience, especially of traumatic experiences (Van der Kolk, 1997). Van der Kolk (1997) stresses the peculiar character of traumatic memories, their extreme persistence in autobiographical memory : "*A century of studies of traumatic memories shows that they generally remain unaffected by other life experiences*" (p. 245) because "*Personally highly significant events generally are unusually accurate* [in memory]*, and tend to remain stable over time*" (p. 247), "*While memories of ordinary events disintegrate in clarity over time, some aspects of traumatic events appear to get fixed in the mind and to remain unaltered by the passage of time or by the intervention of subsequent experience*" (p. 248).

We can assume that memory sins, errors in episodic recalls should not affect the veridicality of the subject's phenomenological recalls of his experience of the Critical Incident under study.

11.3.7. Phenomenological quality of the narrative: the Narrative Authenticity Scale

In a PCA study, the narrative must be evaluated along the discrete values of the Narrative Authenticity Scale (NAS) :

Authenticity levels
3- The narrative was produced by a controlled EI and its phenomenological authenticity was judged, out of signs noted during the EI, good by the researcher
2- The narrative was produced by a controlled EI and its phenomenological authenticity was subjectively judged insufficient, though not poor, by the researcher
1- The narrative was not produced in any of the other manners, the phenomenological authenticity of which can be doubted (for instance a book or a testimony are social reconstructions of actual experiences and have not been properly guided
0- All other materials, including EI's which have failed to induce a pure evocation stance

Table 22 The Narrative Authenticity Scale (NAS)

Lieutenant A's EI scored level 3.

11.3.8. Cross-coding during data processing

Cross-coding means that the resequencing of speech clauses, the semantic elicitation of cognitive operations, and the elaboration of the taxonomy of cognitive acts and objects should be performed by different researchers in parallel.

11.3.9. Ecological validity of the analysis

The results of data processing, i.e. the resequencing of the speech clauses found in the subject's narrative into a chronologically veridical story should be validated by the subject himself.

Beyond, the other results of the data processing phase (cognitive models) and of the data analysis phase (the researcher's findings) should also be validated by peers representing the field of the study.

11.3.10. Traceability of the process

A PCA study does not aim at elaborating nor at assessing a theory of Decision-Making-in-Action or of peritraumatic resilience. But it ambitions to model the cognitive performance of a subject for later comparisons with the PCA study of other subjects in similar circumstances.

Ensuring that the process of a PCA study can be verified by other researchers, its description as well as the data it yields must be included in the research report. In the present case, the elements of the PCA process have been described in details.

11.4. In summary

The PCA methodological framework relies upon three principles that derive from what was exposed in this chapter :

1. It is consistent along all the phases and steps of its process and as such acts as a guide for all reseachers interested in studying cognition in action and specific phenomena affecting it such as the experience of stress or trauma.

2. A number of objections have been raised as they are common when researchers embark on qualitative, often called phenomenological, studies. As shown before, yes, the biases and weaknesses we reminded can possibly affect our research. But no more than other

work undertaken in NDM research. Klein's questionnaire reported by Dekker (2002) or resorting on simulation to observe subjects, as well as verbal protocols can induce the same biases and problems. However, those who undertook such studies have helped make science progress and it is all a matter of rigorous care to prevent or mitigate the side-effects of such a methodological choice.

3. The PCA methodological framework is the result of several years of trials and refinements. If in the first place it was not foreseen to perform exploratory factor analyses, the quality of the data increased along several reanalyses and self-distantiation from the material on hand. The phenomenographic database was an invaluable contribution to this progress and now a pathway between purely psychophenomenological studies and quantitative analyses has been open.

The next part of this report presents the data gained from Lieutenant A's Elicitation Interview and how they were processed to later allow the analysis of the case, among which quantitative exploratory factor analyses.

Part 3. DATA AND THEIR PROCESSING

CHAPTER 12. Collected data

This chapter presents the data gained from the preparatory immersion at the BSPP and from the Elicitation Interview (EI) of Lieutenant A.

12.1. Discovering the BSPP and firemen's naturalistic context of intervention

An immersion of four months at the Montmartre Fire Station of the Paris Fire Brigade (BSPP : Brigade des Sapeurs-Pompiers de Paris) was performed. This station regroups the Headquarters (*EMG1*) of the First Fire Group (*G1*[283]) that covers the North of Paris and adjacent Seine-Saint-Denis suburban areas, and the 9th Rescue Company (*CS9*, 9ème Compagnie de Secours[284]), said to be one of the most active in Europe with no less than 15000 interventions per calendar year in average.

The description of this context is presented in the end notes[285] of the report. In summary, BSPP regulations and practice make fire-fighting a technical activity requiring proper training, a pre-defined organisation and a strict discipline. In the field, interventions are precisely defined : binoms (Firemen always go in pairs for their own safety) are assigned clear goals and they are trained to operate to prescribed standards. The BSPP's motto is "*Rescue or Perish*". When asked "*how are you*", Firemen usually answer "*we had good fires*". They hate the idea that any of them may die in service. The dead on the line of duty are commemorated every month in every fire station : this ritual is meant also to recall the dangers of the profession. Firemen's life in barracks is difficult, and it has always been so (Rolland, 2005). For Men of the rank, it is confined in small dormitories, cantines and solitude. Sub-Officers have decent flats for them and their families. Commanding Officers have larger flats. Training plays a constant and important part in BSPP activities. Unable to pass monthly tests, Firemen can be removed from active service and assigned to administrative or logistic jobs. Their sense of identity may then suffer considerably and psychological support is provided by the Brigade's Chief-Psychologist and colleagues. First year current attrition ratios are around 25 to 30%.

12.2. Transcript of Lieutenant A's narrative

The integral transcript of Lieutenant A's Elicitation Interview is reproduced in ANNEX 7. It is in French. I provide here the compilation of the subject's narrative, fully translated to English as it was resequenced and cleaned up of the researcher's probes. Its fidelity was

validated by the subject in November 2007. ANNEX 12 provides the English translation of speech clauses. The layout of the place where Lieutenant A's action took place, as he drew it during the EI, is in ANNEX 6.

The translation of Lieutenant A's resequenced narrative based on reordered speech clauses is :

Well, I was at the station's switchboard. Then the call taker tells me : Lieutenant the <other station's> VSAV has gone for a person bitten by a rottweiler dog. Are you going ? I say 'listen, as for me now, bitten by a dog… maybe there's something more serious to come up. We'll wait'.

And later on I was still at the call desk. On top of the VSAV there's a pump that's gone, the dogs unit vehicles have gone from <DOGS SPECIALIST STATION> and a resuscitation ambulance. In such a case then maybe… So I left for... <INTERVENTION LOCATION>.

Upon arrival, there are plenty of people on the pavement, a crowd in front of the gate, there's the fence all around the garden, a large gate, nearly two meters high, one cannot see through, that's open, with the police. You have walls all around, the gate there, fencing all around.

So I drive in. The house is here (he draws). There was a terrace at the front, a large house, and here there were two tents, you know, like a circus tent.

I spot the police here, there (he draws), but I don't join them (in the back of the garden) immediately.

I walk into the house. Then I noticed on a small table, on the terrace, some hairs on a table.

I hear a woman crying. I see this disorder as I enter, I see that mess, I see the sofa, that woman seated head bent backwards, a woman, a young woman.

Her mother speaks, the daughter yells.

The mother, on the floor, was not seriously hurt, she was shocked, she had a faint, stress.

The young woman was bitten. She was saying 'I hurt, you must anaesthetise me, do something.

Of course she hurts.

I don't pay too much attention, rather I hear the mother.

The daughter has blood all over her face. I couldn't see much. She had only hair left on the back of her head, she was completely scalped, one could see her scull. As I had walked earlier from the car to the house, I had noticed a wig on a small table on the terrace at the front of the house, some hairs on a small table. And also she is cut and bitten all over.

I can't keep watching this young woman all the time, the worst case of the two.

Some time later I hear that there was also a baby, in the house.

All around well it's a brouhaha of medical terms, with the SAMU. The SAMU was there, there was the VSAV that was dealing with the victims. Well they were talking between them, I didn't know really, I saw they were taking care of them.

Because the dogs were the only thing I had not yet seen, I spot my driver there who is going to help them, another team with two other guys there. Then I saw that they were all taking care of these two victims. I told my driver 'then you take care of- you stay here with them, and I go outside see what's going on'.

And then I then I go out and I see the police who deal with the dogs. Finally I'm standing here, I keep an eye on the dogs. When I'm outside I tell myself the dogs must be dealt with swiftly. There was well a good 50 people and I didn't even count them, a crowd, but they were looking over, to see what was going on.

I walked down this way, there, the terrace was like this, some steps down here (he draws), I walked back to the front gate to close it.

I sent the message, and then the father had not yet arrived. After that I walk back at the foot of the terrace.

The young police woman was in charge of the radio {he performs a hand movement symbolising the radio}, a policeman here {draws a little circle to position the policeman who was standing right behind him from the dog}, and here I had some other guys {draws two or three firemen standing behind him} with me. We were standing there, we were three of four.

That's where I saw the police who were pointing their guns at the two dogs, at the end of the garden. The dogs were calm well, they didn't move. There were trees there and there {on the map, he points to the left end of the garden}, they were behind these trees. The dogs that's the squares (he draws). One of the dogs was lame in a leg. Then the dogs didn't move, they were calm, everything was OK. The dogs were surrounded, taken in pincers by the police who were pointing guns at them.

We were only expecting the veterinary, and the dogs unit to capture the dogs and to put them into a cage.

I try to switch mind a bit…

We were waiting, for about ten minutes, the dogs were immobile, they were calm, everything was going OK apart from the young girl, she needed care.

Well to try to switch mind a bit, from the outside I later saw that the mother was shocked and that the medics had placed her in a chair, with an oxygen mask. She was shocked. They start to perfuse them.

We chat from time to time, we try to talk to one another, and at that point everything was OK, well, in brackets… I can't remember because after that I was obsessed by the dogs.

And the father arrives, fuming, a tall guy. He didn't even go to see inside the house.

Kill my dogs ! Kill my dogs !… You must kill them !

He walks past me. I say 'calm down'.

And at this point it all happened very quickly.

I say 'calm down Sir'. Then a policeman says 'calm down Sir' and the father re starts walking toward the dogs. The father says 'no, no'.

'Calm down Sir'…

The policeman grabs him, and then the dogs, immediately, get up on their legs, immediately, and attack.

I see the dog arriving. They attack us. And from that moment, I saw only the dog, the two dogs that were jumping at us. They jump at us.

The police had already their guns in hand and then I tell the police 'shoot', yes yes, 'shoot, shoot, shoot'.

He shoots backwards, with the father who gets back on his feet, the policeman who shoots, the father who was afraid too, as frightened as us. And the three police officers, there {those who were in front of him, facing the dogs}, start shooting.

I could see these policemen in front of me, there, who were shooting at the two dogs, and there was this police woman in front of me with the other policeman then who was shooting. Both policemen were shooting at the dogs who were advancing, who were moving on, moving on.

It’s like 14th of July petards well, like a machine gun as they were shooting so much.

When the dogs started charging--- and they were shooting--- it’s not- how to say ?, it’s not the fear of the petards, well, of the guns, it was the fear of the dogs.

All the shots…

And space became like a tube.

At the time (of the dogs attacking) I could see only that blue eye ; the dog she she- well, the dog that was getting at me like this.

I see myself moving backward, I move back two three meters, in addition I hurt my hand on the terrace, moving next to the policeman.

I see the bullets’ impacts, they get into the dog but that does not hurt her and she keeps running, she keeps running, running.

The dog, that makes them deviate, the dog falls, gets back up on her legs, restarts and runs past us.

I could see these policemen in front of me, there, who were shooting at the dogs, and the dogs who were running running running, then the dog, it makes them deviate.

I see see myself, I'm telling myself 'but they don't know how to shoot' or 'they don't shoot in the proper direction'.

And then this dog there, one of the dogs didn't manage to reach us. With the bullets, she went to the right and to hide in a bush. That one, she crossed here, till there, and restarted, that way {he points to the gate on the map}.

I say 'then we're done' because well, then we could have found her there…

Our priority was to find the missing dog. Someone says 'there's a dog in the grove, she's dying. Good, then she, good. Then someone else says 'but where is the second dog?'.

When they started shooting, they saw the dog run off that way {toward the front gate to the street}. Then here {he draws the space of the car parked in the garden, left of the north-east angle of the map} there's a car. We thought she was hiding under the…, she ran under the car, but nobody saw it turn to the right.

The dogs unit arrive with their lassos, they wore polo necks, shirts. I tell them 'well, but you don't wear gear to capture them ?’. He comes to me : ‘well' no no, we the lasso will do’.

But then I tell myself no I… I'll never have dogs.

I followed the dogs unit, I went that way {to the adjacent garden on the south side}, I went down to the shade, a little gate, that was open. There was an adjacent parcel, with a shade, here {he draws the store on the left of the south side of the map}.

There's a policeman who says 'the dog escaped'. Here no one was guarding the gate. And that gate had staid open by the father. And then immediately we say 'but where is this dog ? We have a dog missing she ran away'.

The dogs unit went into the shade, found nothing. Then, here we go, we go around, we search. Here there was a cellar, therefore we searched the cellar. Well, we sent the dogs unit search the cellar.

I say 'we didn't found any dog'. I come back that way (clockwise) and as I was arriving there, only after a while, I hear a policeman say 'the dog is there, she's hiding'. Because there was a black mass. She had sought refuge in the grove. Finally, after three minutes only it was found, she had gone around, she had found refuge, like the other dog, a bit further, behind a grove {he draws the route taken by the dog around the house, clockwise}. And there, now, once everything, both dogs were there, well everything was sorted out, they were half dead in the grove, the dogs unit had collected the dogs bodies.

The veterinary didn't arrive immediately

And when the dogs were under control because they had been shot dead, I briefly spoke with a colleague. He says 'they shot all around in a mess'. I reply 'Yes, we might have been hit---'. It's at this point that one said 'on top of being bitten, maybe we could have been shot'.

I say 'yes yes it was like like a machine gun shot, yes we could have been shot, once, maybe twice, yes, but they shot what ten ten ten, they must have shot ten bullets'.

So I inquire because I see some other police officers there, I go to see the police officers and I ask 'but how many bullets did you fire ?'.

'Hhmm well', he says, 'me well I emptied the charger'.

Then I say 'how many bullets in a charger ?'.

'Fifteen, hhmm I fired fifteen'.

I say 'but but what about the others ?'.

'Well', he says, 'well I have a colleague, it's the same, he emptied the charger hhmm and the others they shot too'.

They said they were pointing their guns toward the ground, well, OK…

Then the forensics unit arrives, the commissioner arrives, the police commissioner, and lieutenants with plenty of envelopes and everything then. They arrive with all their equipment.

Then I inquired later. I learned that there had been 45 bullets shot. I learn finally that in a charger there are, I think there are ten or fifteen bullets, and that two policemen emptied their charger, and I told myself 'already twenty or thirty, plus the others'. And at the end, before I left, I learn 45 bullets had been shot, three chargers. I think it's fifteen bullets there are in a charger.

Because they must collect all the cases, all the cases of the bullets, I tell myself they will have luck if they can find the bullets ! And also that if it's like in The Experts on TV, they haven't made it yet. Then I even ask one of the forensics 'but do you have metal detectors to find the cases ?'.

He says 'no no we don't have that'. So I say 'well it's it's going to be hard work then'.

And then, then it all works on my brain, not the shooting story then, it's the intervention that comes to an end, I must attend back to the victims to see how much progress they had made, to know where the doctor would send the victims.

After that I went back inside the house. There's the doctoress who says to me 'you--', how do you say that ?, 'you neared true disaster', something like that, 'it could have been dramatic'.

I say 'yes nearly'.

Them, after that, when they told us 'but what happened ? We heard heavy gun shooting', and other colleagues who said 'pfff it was heavy shooting', I say 'yes yes'.

Because there's a fence all around the garden, after we found the dogs, a short while afterwards, I tell myself 'all that could have happened, it would be bad to find a dead grandma a few days later shot with a bullet in the head while watching TV'.

Five firemen plus SAMU, then they are three or four, nine people in total, for two victims ! That's plenty, then all those who don't have anything to do inside, well there were some outside to watch the engine, drivers, and here we were three or four, then plus these, then I sent one of the guys to check on adjacent properties (if everyone was safe).

I send all the messages and all and I want to know about the progress, where victims are to be dispatched.

They are going to <HOSPITAL 1>, there was the resuscitation ambulance, it went very quickly. Before it starts the engine I ask the doctoress if her days are in danger, the young woman, if she's at risk.

'Her life no', but what does she say ?, 'her life--- psychologically and aesthetically yes, her life is jeopardised'. And they leave.

The mother, my men wanted to walk her, because she wasn't…, they wanted to walk her to the front gate. She was due to be dispatched to <HOSPITAL 2>. Still some people were watching outside, on the right on the left, they're nosy.

I say 'no no no, there are still people who watch on the right and left, they're nosy, bring that PSR {emergency rescue and reanimation vehicle} backward, where the ambulance was'. And the woman got in.

When we left, there were TV people from <TELEVISION CHANNEL>.

'TV ? Well, as instructed, they may shoot, but we say nothing'.

I seat back in the car, well, and it's when, well, about the shooting, it's when it restart to work on my mind, more. The driver is next to me. While we drive back to the station I say 'pfff we could have been bitten, we could have- have been shot'. I tell myself 'yes but if the cops had not fired their guns 'maybe it's me who would have been bitten but it's not me who pulled the father down'. But I say 'there might have been one or two bitten police officers should they have not fired their guns'.

Well after that, I talked about it at the station, I talked about the whole intervention what happened, even several times, several times with colleagues…

CHAPTER 13. Data processing

This chapter extracts cognition-related data from the subject's narrative, explores their structure and elaborates their taxonomy (Bailey, 1994) that, we hope, will be reusable by other researchers, and that provides the consistent basis for further processing and analytic work. We reorder chronologically the cognitive operations elicited from the semantic, interpretative analysis of the subject's speech clauses. We present the process model, or cognigraph, of the subject's cognitive activity during the episode. An analysis of the frequency of phenotypic succession links between cognitive operations allows us to draw Decision Network models of Lieutenant A's cognitive activity. Finally, we discuss the scientificity of our data processing work and its limits. In this chapter, we chose to present the detailed elements of taxonomy and the grounds of our semantic analysis of the narrative for the reader to be fully aware of both the interest and limitations of our work. It seems the only way to engage this same reader into a constructive discussion and critique of our methodological approach in view of future research endeavours.

13.1. Structure of the story

13.1.1. Hierarchical structure of the story

We found the structure of Lieutenant A's story to be composed of :

- 10 *CI Experience Phases*, themselves divided in
- 26 meaningful segments (called *Speech Units* in the Phenomenographic database), divided in
- 44 *Present Moments*.

Experience Phases	Speech Units	Present Moments
0 Ante-Action – Nominal	00 - At the fire station	00 - Before it started
0 Ante-CI - Nominal	01 - Doubts and economy	01 - Waiting to see…
	02 - It's really serious	02 - Deciding to intervene
	03 - Getting to the scene	03 - Deciding to park in the garden
	04 - Initial decision	04 - Deciding to attend to the victims
	05 - Discovering the victims' fate	05 - Attending to the victims and leaving
	06 - Going back to the dogs	06 - Deciding to close the front gate on the way back to dogs
		07 - Deciding to send an ambience message to BSPP
1 Pre-CI Signals - Stressful	07 - A precarious situation…	08 - Distracting from anxiety

		09 - A glimpse of the victims
2 Pre-CI Tension - Stressful	08 - The father's arrival raises the level of risk	10 - The father irrupts…
3 CI Trauma Exposure - Traumatic	09 - Dogs attack…	11 - The dogs attack !!! Shoot them ! Shoot ! Shoot !
		12 - The fright
4 CI Post-Tension - Stressful	10 - A dog escaped !	13 - Searching the missing dog
	11 - The dog specialists arrive	14 - Continuing the search and being astonished by the dogs unit
	12 - Where is the missing dog ?	15 - Following the dogs unit into the adjacent parcel
		16 - Searching the adjacent parcel : worrying !
	13 - No the dog didn't escape to the street	17 - Going back into the garden
		18 - Searching the cellar
	14 - No the dog is not in the cellar	19 - No luck with the cellar : restarting the search
5 CI Post-Relief - Stressful	15 – It's been found in a grove !	20 - The dog has been found !
		21 - Seeing the dogs dying
6 CI Post-Venting - Stressful	16 - We nearly got killed, didn't we ?	22 - First realisation of what went on
		23 - A quick chat with a colleague…
		24 - Asking questions about the shooting
	17 - I'll ask the Police	25 - Further questions about the shooting
		26 - First answers…
		27 - 15 Bullets ?…
	18 - Forensics arrive	28 - Even more
		29 - 45 bullets !
		30 - Why do they carry envelops ?
		31 - They need to collect the bullets
		32 - Good luck with the bullets then !
7 CI Post-Resumption - Stressful	19 - I need to attend back to the victims now	33 - Deciding to go back inside
	20 - You got close to disaster	34 - What happened ?, she asks
		35 - It sounded like heavy gun fire, colleagues say
	21 - Could a bullet have shot a neighbour ?…	36 - Could neighbours have been shot too ?…
	22 - The scalped woman's evacuation	37 - Deciding to ask where victims are to be dispatched
		38 - Asking about the daughter
	23 – The mother's evacuation	39 - You can't walk that woman in her condition !
		40 - The crowd are watching : bring the PSR inside !
	24 - A television crew is here !…	41 - The mother departs : time to report and go
	25 - About to leave	42 - Back in the car, sending radio message
8 CI Post-Debriefing – Stressful	26 - Back in the car, talking with the driver	43 - Starting to think and talk about the events
		44 - Reflecting upon the course of things

Table 23 The hierarchical structure of Lieutenant A's story Cognitive taxonomy

13.1.2. The phases of Lieutenant A's experience of the Critical Incident

The initial action ("*Well, I was at the station's switchboard.*") that constitutes an *ante-action* phase of the story was not taken into account in further data processing and analysis : Lieutenant A was standing by the fire station's call desk, waiting for likely emergencies, which is his last action before the actual action under study starts. However, an *Ante-Action* experience phase was created to account for this starting point of the story and to distinguish it in later analyses should it have to. The *Post-CI* phase was elicited but the subject's narrative of this phase was insufficiently detailed to be taken into account in the data processing and analysis process. Identified CI experience phases are :

CI Experience Phases	Stressfulness
0 Ante-Action : before the action considered for analysis even started (the initial context)	Nominal
0 Ante-CI : before exposure to the critical incident	Nominal
1 Pre-CI signals : the subject perceives early warnings of a possible Critical Incident	*Stressful*
2 Pre-CI tension : the subject is under emotional pressure	*Stressful*
3 CI Trauma Exposure : he experiences Trauma (Traumatism)	**Traumatic**
4 CI Post-Tension : he experiences some sequels of the traumatic encounter	*Stressful*
5 CI Post-Relief : at this point the subject finds out that adversity is over	*Stressful*
6 CI Post-Venting : the subject now inquires about events to understand what happened	*Stressful*
7 CI Post-Resumption : the subject is free to return to his mission but he faces others' questions	*Stressful*
8 CI Post-Debriefing : the subject needs to talk about events with colleagues or family	*Stressful*
9 Post-CI : the subject returns to his normal life and writes an official report about the events	Nominal

Table 24 Definitions of the phases of Lieutenant A's experience of the Critical Incident

Here, *stressfulness* indicates if we considered a subject's experience phase as nominal (non stressful, non traumatic), stressful or traumatic. Phase 3 is the traumatic one.

13.1.3. The 44 Present Moments and associated narratives

The subject's reconstituted narrative can be parsed along the 44 Present Moments as follows :

PM	Narrative
00 - Before it started	Well, I was at the station's switchboard.
01 - Waiting to see…	Then the call taker tells me : Lieutenant the <other station's> VSAV has gone for a person bitten by a rottweiler dog. Are you going ? I say 'listen, as for me now, bitten by a dog… maybe there's something more serious to come up. We'll wait'. And later on I was still at the call desk
02 - Deciding to intervene	On top of the VSAV there's a pump that's gone, the dogs unit vehicles have gone from <DOGS SPECIALIST STATION> and a resuscitation ambulance. In such a case then maybe… So I left for... <INTERVENTION LOCATION>.
03 - Deciding to park in the garden	Upon arrival, there are plenty of people on the pavement, a crowd in front of the gate, there's the fence all around the garden, a large gate, nearly two meters high, one cannot see through, that's open, with the police. You have walls all around, the gate there, fencing all around. So I drive in
04 - Deciding to attend to the victims	The house is here (he draws). There was a terrace at the front, a large house, and here there were two tents, you know, like a circus tent.

	I spot the police here, there (he draws), but I don't join them (in the back of the garden) immediately. I walk into the house.
05 - Attending to the victims and leaving	Then I noticed on a small table, on the terrace, some hairs on a table. I hear a woman crying. I see this disorder as I enter, I see that mess, I see the the sofa, that woman seated head bent backwards, a woman, a young woman. Her mother speaks, the daughter yells. The mother, on the floor, was not seriously hurt, she was shocked, she had a faint, stress. The young woman was bitten. She was saying 'I hurt, you must anaesthetise me, do something. Of course she hurts. I don't pay too much attention, rather I hear the mother. The daughter has blood all over her face. I couldn't see much. She had only hair left on the back of her head, she was completely scalped, one could see her scull. As I had walked earlier from the car to the house, I had noticed a wig on a small table on the terrace at the front of the house, some hairs on a small table. And also she is cut and bitten all over. I can’t keep watching this young woman all the time, the worst case of the two. Some time later I hear that there was also a baby,
06 - Deciding to close the front gate on the way back to dogs	and I see the police who deal with the dogs. Finally I'm standing here, I keep an eye on the dogs. When I'm outside I tell myself the dogs must be dealt with swiftly. There was well a good 50 people and I didn't even count them, a crowd, but they were looking over, to see what was going on. I walked down this way, there, the terrace was like this, some steps down here (he draws), I walked back to the front gate to close it
07 - Deciding to send an ambience message to BSPP	I sent the message, and then the father had not yet arrived. After that I walk back at the foot of the terrace.
08 - Distracting from anxiety	The young police woman was in charge of the radio {he performs a hand movement symbolising the radio}, a policeman here {draws a little circle to position the policeman who was standing right behind him from the dog}, and here I had some other guys {draws two or three firemen standing behind him} with me. We were standing there, we were three of four. That's where I saw the police who were pointing their guns at the two dogs, at the end of the garden. The dogs were calm well, they didn't move. There were trees there and there {on the map, he points to the left end of the garden}, they were behind these trees. The dogs that's the squares (he draws). One of the dogs was lame in a leg. Then the dogs didn't move, they were calm, everything was OK. The dogs were surrounded, taken in pincers by the police who were pointing guns at them. We were only expecting the veterinary, and the dogs unit to capture the dogs and to put them into a cage. I try to switch mind a bit… We were waiting, for about ten minutes, the dog
09 - A glimpse of the victims	from the outside I later saw that the mother was shocked and that the medics had placed her in a chair, with an oxygen mask. She was shocked. They start to to perfuse them. We chat from time to time, we try to talk to one another
10 - The father irrupts…	and at that point everything was OK, well, in brackets… I can't remember because after that I was obsessed by the dogs. And the father arrives, fuming, a tall guy. He didn't even go to see inside the house. Kill my dogs ! Kill my dogs !… You must kill them ! He walks past me. I say 'calm down'. And at this point it all happened very quickly. I say 'calm down Sir'.
11 - The dogs attack !!! Shoot them ! Shoot ! Shoot !	Then a policeman says 'calm down Sir' and the father re starts walking toward the dogs. The father says 'no, no'. 'Calm down Sir'… The policeman grabs him, and then the dogs, immediately, get up on their legs, immediately, and attack. I see the dog arriving. They attack us. And from that moment, I saw only the dog, the two dogs that were jumping at us. They jump at us. The police had already their guns in hand and then I tell the police 'shoot', yes yes, 'shoot, shoot, shoot'.

12 - The fright	He shoots backwards, with the father who gets back on his feet, the policeman who shoots, the father who was afraid too, as frightened as us. And the three police officers, there {those who were in front of him, facing the dogs}, start shooting. I could see these policemen in front of me, there, who were shooting at the two dogs, and there was this police woman in front of me with the other policeman then who was shooting. Both policemen were shooting at the dogs who were advancing, who were moving on, moving on. It's like 14th of July petards well, like a machine gun as they were shooting so much. When the dogs started charging--- and they were shooting--- it's not- how to say ?, it's not the fear of the petards, well, of the guns, it was the fear of the dogs. All the shots… And space became like a tube. At the time (of the dogs attacking) I could see only that blue eye ; the dog she she- well, the dog that was getting at me like this. I see myself moving backward, I move back two three meters, in addition I hurt
13 - Searching the missing dog	Our priority was to find the missing dog. Someone says 'there's a dog in the grove, she's dying. Good, then she, good. Then someone else says 'but where is the second dog?'. When they started shooting, they saw the dog run off that way {toward the front gate to the street}. Then here {he draws the space of the car parked in the garden, left of the north-east angle of the map} there's a car. We thought she was hiding under the…
14 - Continuing the search and being astonished by the dogs unit	she ran under the car, but nobody saw it turn to the right. The dogs unit arrive with their lassos, they wore polo necks, shirts. I tell them 'well, but you don't wear gear to capture them ?'.
15 - Following the dogs unit into the adjacent parcel	He comes to me : 'well' no no, we the lasso will do'. But then I tell myself no I… I'll never have dogs. I followed the dogs unit, I went that way {to the adjacent garden on the south side}, I went down to the shade
16 - Searching the adjacent parcel : worrying !	a little gate, that was open. There was an adjacent parcel, with a shade, here {he draws the store on the left) of the south side of the map}. There's a policeman who says 'the dog escaped'. Here no one was guarding the gate. And that gate had staid open by the father. And then immediately we say 'but where is this dog ? We have a dog missing she ran away'.
17 - Going back into the garden	The dogs unit went into the shade, found nothing. Then, here we go, we go around, we search.
18 - Searching the cellar	Here there was a cellar, therefore we searched the cellar. Well, we sent the dogs unit search the cellar. I say 'we didn't found any dog' I come back that way (clockwise)
19 - No luck with the cellar : restarting the search	and as I was arriving there,
20 - The dog has been found !	only after a while, I hear a policeman say 'the dog is there, she's hiding'. Because there was a black mass. She had sought refuge in the grove. Finally, after three minutes only it was found, she had gone around, she had found refuge, like the other dog, a bit further, behind a grove {he draws the route taken by the dog around the house, clockwise}. And there, now, once everything, both dogs were there, well everything was sorted out, they were half dead
21 - Seeing the dogs dying	in the grove, the dogs unit had collected the dogs bodies. The veterinary didn't arrive immediately
22 - First realisation of what went on	And when the dogs were under control because they had been shot dead, I briefly spoke with a colleague. He says 'they shot all around in a mess'. I reply 'Yes, we might have been hit---'. It's at this point that one said 'on top of being bitten, maybe we could have been shot'.
23 - A quick chat with a colleague…	I say 'yes yes it was like like a machine gun shot,
24 - Asking questions about the shooting	yes we could have been shot, once, maybe twice, yes, but they shot what ten ten ten, they must have shot ten bullets'.
25 - Further questions about the	So I inquire because I see some other police officers there, I go to see the police officers and I ask 'but how many bullets did you fire ?'.

shooting	
26 - First answers…	‘Hhmm well’, he says, 'me well I emptied the charger'. Then I say 'how many bullets in a charger ?'.
27 - 15 Bullets ?…	‘Fifteen, hhmm I fired fifteen’. I say 'but but what about the others ?'.
28 - Even more	‘Well’, he says, 'well I have a colleague, it's the same, he emptied the charger hhmm and the others they shot too'. They said they were pointing their guns toward the ground, well, OK… Then the forensics unit arrives, the commissioner arrives, the police commissioner, and lieutenants with plenty of envelopes and everything then. They arrive with all their equipment. Then I inquired later. I learned that there had been 45 bullets shot.
29 - 45 bullets !	I learned that there had been 45 bullets shot. I learn finally that in a charger there are, I think there are ten or fifteen bullets, and that two policemen emptied their charger, and I told myself 'already twenty or thirty, plus the others'. And at the end, before I left, I learn 45 bullets had been shot, three chargers. I think it's fifteen bullets there are in a charger.
30 - Why do they carry envelops ?	Because they must collect all the cases, all the cases of the bullets,
31 - They need to collect the bullets	I tell myself they will have luck if they can find the bullets ! And also that if it's like in The Experts on TV, they haven't made it yet. Then I even ask one of the forensics 'but do you have metal detectors to find the cases ?’.
32 - Good luck with the bullets then !	He says 'no no we don't have that'. So I say 'well it's it's going to be hard work then'.
33 - Deciding to go back inside	And then, then it all works on my brain, not the shooting story then, it's the intervention that comes to an end, I must attend back to the victims to see how much progress they had made, to know where the doctor would send the victims. After that I went back inside the house
34 - What happened ?, she asks	There's the doctoress who says to me 'you--', how do you say that ?, 'you neared true disaster', something like that, 'it could have been dramatic'. I say 'yes nearly'.
35 - It sounded like heavy gun fire, colleagues say	Them, after that, when they told us 'but what happened ? We heard heavy gun shooting', and other colleagues who said 'pfff it was heavy shooting', I say 'yes yes'.
36 - Could neighbours have been shot too ?…	Because there's a fence all around the garden, after we found the dogs, a short while afterwards, I tell myself 'all that could have happened, it would be bad to find a dead grandma a few days later shot with a bullet in the head while watching TV’. Five firemen plus SAMU, then they are three or four, nine people in total, for two victims ! That's plenty, then all those who don't have anything to do inside, well there were some outside to watch the engine, drivers, and here we were three or four, then plus these, then I sent one of the guys to check on adjacent properties (if everyone was safe).
37 - Deciding to ask where victims are to be dispatched	I send all the messages and all and I want to know about the progress, where victims are to be dispatched.
38 - Asking about the daughter	They are going to <HOSPITAL 1>, there was the resuscitation ambulance, it went very quickly. Before it starts the engine I ask the doctoress if her days are in danger, the young woman, if she's at risk.
39 - You can't walk that woman in her condition !	Her life no', but what does she say ?, 'her life--- psychologically and aesthetically yes, her life is jeopardised'. And they leave. The mother, my men wanted to walk her, because she wasn't…, they wanted to walk her to the front gate.
40 - The crowd are watching : bring the PSR inside !	I say 'no no no, there are still people who watch on the right and left, they're nosy, bring that PSR {emergency rescue and reanimation vehicle} backward, where the ambulance was’
41 - The mother departs : time to report and go	And the woman got in. When we left, there were TV people from <TELEVISION CHANNEL>. ‘TV ? Well, as instructed, they may shoot, but we say nothing’.
42 - Back in the car, sending radio	I seat back in the car

message	
43 - Starting to think and talk about the events	well, and it's when, well, about the shooting, it's when it restart to work on my mind, more. The driver is next to me. While we drive back to the station I say 'pfff we could have been bitten, we could have- have been shot'.
44 - Reflecting upon the course of things	I tell myself 'yes but if the cops had not fired their guns 'maybe it's me who would have been bitten but it's not me who pulled the father down'. But I say 'there might have been one or two bitten police officers should they have not fired their guns'. Well after that, I talked about it at the station, I talked about the whole intervention what happened, even several times, several times with colleagues…

Table 25 Decomposition of Lieutenant A's narrative into 44 Present Moments

13.2. Chronotext : resequencing speech clauses and interpretative difficulties

The following table presents the chronotext of the first two speech units (SU) of the story. ANNEX 9 presents the exhaustive chronotext through which the subject's utterances are chronologically resequenced.

SU	N SEQ	SC #[286]	Speech Clause	Initial interpretation made during semantic parsing
01 – Doubts and economy	1	8-1-ZZZZZ-ZZZZZ	Ben, j'étais, j'étais au standard, au standard de la caserne	ACTION: he was standing at the call desk
01 - Doubts and economy	2	8-2-ZZZZZ-ZZZZZ	là, et euh y'a un le stationnaire qui me dit que euh… " mon lieutenant, y'a le VSAV de <OTHER FIRE STATION> qui est parti euh pour une personne mordue par un ch… mordue par un rottweiler.	"le stationnaire qui me dit" - he hears the call taker's utterance - his attention is awakened ????? - he hears it's about a woman bitten by a rottweiler dog - he hears a rescue vehicle (VSAV) has gone - he understands the intervention situation at hand
01 - Doubts and economy	3	8-3-ZZZZZ-ZZZZZ	Est-ce que vous y allez ?	he hears a question
01 - Doubts and economy	4	8-4-ZZZZZ-ZZZZZ	pour l'instant--- mordu par un chien c'est pas--- y'a p't'être d'autres choses plus graves	pour l'instant--- he evaluates the situation : does it deserve that I go vs. staying at the station - he evaluates it's not so serious ("bitten by a dog that's not---") - he knows he is not supposed to intervene unless serious case - he knows from experience more important cases may appear (" there may be more serious stuff") - he considers possible decisions (go or no go) - he weighs pros and cons ("for now---")
01 - Doubts and economy	5	8-5-ZZZZZ-ZZZZZ	on va attendre	he forms an idea of what to do ("we'll wait")
01 - Doubts and economy	6	8-6-ZZZZZ-ZZZZZ	Bon alors, j'dis ben moi, écoute	- he makes a decision ("well, then---") - he justifies himself internally ("listen---") = he checks its consistency against his moral / professional (ethical) code

SU	N SEQ	SC #[286]	Speech Clause	Initial interpretation made during semantic parsing
01 - Doubts and economy	7	8-7-ZZZZZ-ZZZZZ	j'dis ben moi, écoute, euh, pour l'instant--- mordu par un chien c'est pas--- y'a p't'être d'autres choses plus graves, on va attendre	- he prepares his answer ("listen, well, for now etc...") so as to make the call taker understand that he has weighed the pros and cons - ACTION : he utters his reply, says he'll wait ("I say" + "we'll wait")
02 - It's really serious	1	8-8-ZZZZZ-ZZZZZ	Et puis j'étais toujours au standard	- ACTION: he is waiting by the desk ("And later on I was still at the call desk")
02 - It's really serious	2	8-9-ZZZZZ-ZZZZZ	y'a, y'a--- euh--- (nss) en plus de ce VSAV y'a y'a un engin pompe qui est parti en plus euh--- les les véhicules cinotechniques de <DOGS SPECIALIST STATION> et euh--- euh une ambulance de réanimation.	- he hears that another truck has been sent to the scene - he hears that the dogs specialist unit is on its way too - he hears that a resuscitation ambulance is also on its way
02 - It's really serious	3	8-10-356-1	oh, eh bien oui, de toute façon, c'est euh, comme j'ai dit aux policiers, j'avais déjà fait des interventions avec des chiens, des chiens mordus, enfin, des gens mordus par des chiens, où nos équipes cinotechniques interviennent et attrapent les chiens	- he remembers (LTM / EM / AM[287]) the characteristics of such an intervention
02 - It's really serious	4	8-10-ZZZZZ-ZZZZZ	là peut-être	"là" "là" means "in such a case" : - he has recognised the situation as serious
02 - It's really serious	5	8-11-ZZZZZ-ZZZZZ	Alors	"Alors" = "therefore" / "in that case" : - I interpret it as "in such a case, he recalls his regulation manual"
02 - It's really serious	6	8-12-ZZZZZ-ZZZZZ	là peut-être	"peut-être" = "maybe" => this shows that his decision is not straight forward ; he has some hesitation : 1) he says to himself he cannot not intervene on a serious case 2) I assume (knowing his personal history of the time : he had been bitten by a dog three weeks before, I have been told) - he wouldn't like to be harmed again 3) he explicitly says "maybe", marking his hesitation even if that may be only a ready-made phrase - he hesitates to go
02 - It's really serious	7	8-17-ZZZZZ-ZZZZZ	Alors j'dis	- he comes to a decision : he chooses to go - ACTION: so he says
02 - It's really serious	8	8-18-ZZZZZ-ZZZZZ	Bon ben j'suis parti à--- à <INTERVENTION LOCATION>	"Bon ben" = "well… then" : - ACTION : he rushes to the car (he may also have called his driver if he were not at the call desk, he will have dialogs in the car: first of all asking his driver if he knows where to go, finding the place on the map if they don't

SU	N SEQ	SC #[286]	Speech Clause	Initial interpretation made during semantic parsing
				know, … but we consider these actions as one single action : leaving the station and driving off)

Table 26 Chronotext of the first two speech units

The sequence tags and reordering choices were carefully considered several times. The result was validated by Lieutenant A in November 2007.

Here, what is of real importance is the difficulty to perform the semantic analysis of speech clauses. This semantic analysis of speech clauses has varied to a limited extent between the several rounds of analysis we performed and even until the elaboration of the cognigraph. This was due to the fact that the progressive refinement of the identification and definition of CogOps may have induced some changes in the interpretation of what was said by Lieutenant A.

In practice, this semantic interpretation was made difficult by the impossibility to apply the kind of semantic analysis that yields entity-relationship models in computing science where analysed sentences and propositions are expressed in well formulated management rules. Here, the subject's language is not so well controlled. He verbalises his recalls as they pop-up, sometimes with an effort, sometimes with a sense in his mind of the disorder in which he says things, sometimes probably with doubts as to the exactness of his memories, and sometimes he may feel emotional and this creates difficulties of expression. Our initial attempt was to apply the classic data modelling technique used in computing science and founded on the elicitation of classes within sentences. Finally, we had to give-up this path for the reasons mentioned above.

13.3. Cognitive taxonomy : the result of the semantic analysis

The semantic analysis of the narrative revealed, or allowed to assume, the performance of 460 CogOps (Cognitive Operations) i.e. 460 pairs of {CogAct ; CogObj}. This process started with the semantic elicitation of *sub-types*. It required several rounds of progressive refinement. Those led to progressively refine the wording and definition of each sub-type (CogActST and CogObjST) and to group sub-types into *types* of a higher order of abstraction. For instance CogActST were grouped into a CogAct. Then, CogActs themselves were in turn grouped into higher-order cognitive *families*. In this taxonomy categories were sought to be *orthogonal*, i.e. without an intersection of their definitions

(this point included orthogonality, independence among CogActs, among CogObjs and between CogActs and CogObjs as well). This principle applied both at the sub-type, at the type and at the families levels.

Another researcher might have created different taxonomies. But what is of importance to the present research is 1) that successive refinements have yielded consistency in our taxonomy, 2) that this taxonomy allowed us to perform a study of the subject's cognition in action that revealed patterns and allowed to study their variations, and 3) that our taxonomy constitutes a departure point for later works by other researchers. When other research teams will perform similar studies their concern will become that of taxonomic choices and the categories presented here may then be updated.

13.3.1. Cognitive acts (CogAct) : families, types, sub-types, and definitions

The sub-types, types and families of CogActs are :

Family	CogAct	CogActST (sub-type
A01- Learning	LEARNING	LRN21- Noting / Memorising (a lesson = attitude, chunk of semantic Knowledge, ...)
A01- Soliciting Attention & STM	ATTENDING	ATT21- Scanning actively / Searching (for cues / expectations)
		ATT23- Discriminating / Singling out (a cue / stimulus)
		ATT31- Focusing on (focus / stimulus)
		ATT33- Reviving / Re-awakening / Re-attending to (focus)
		ATT34- Being attracted / distracted by (distractor) from (focus)
	STM KEEPING	STM31- Remembering (STM data)
A01- Soliciting LTM	REMEMBERING	MEM11- Passive Recall: remembering / evoking
		MEM21- Active Search: trying to remember
		MEM23- Active Search: failing to remember (memories in relation to object)
A02- Perceiving	PERCEIVING	PER11- Seeing (---not in slow motion => or select Dissociate / see in slow motion---) / read
		PER12- Hearing / learning (something from someone, feedback from COA / COE)
		PER17- Sensing (have a sensation, physical or mental)
		PER21- Failing to perceive
A03- Intuiting / Imagining	PRO/PARA-TENDING	PRO11- intuiting / anticipating / foreseeing / seeing as imminent / expecting
A03- Reasoning	ELABORATING	ELB11- Elaborating / Setting / forming / constructing / devising / conceiving
		ELB13- Reaffirming (an intention / motivation / …)
	ORIENTING	ORT11- Wanting / Wanting to do / to know
		ORT12- Wishing / Hoping / Expecting
		ORT14- Setting priorities / a priority
		ORT21- Sharing / Following / Replicating / Sticking to (a prescribed previous plan / intention / motive) / obey
		ORT31- Willing not / Wishing not
		ORT41- Hesitating (between plans / options)
	REFLECTING	ANA11- Analysing / diagnosing
		ANA12- Counting / Measuring / calculating / computing
		ANA13- Evaluating (Status of a situation / State of person /

		object…)
		ANA40- Considering / studying / examining (alternatives)
		ANA41- Assuming / hypothesising
		REF11- Ruminating / Thinking deeply (of sthg)
		REF12- Saying to oneself / Dialoguing with oneself
		REF13- Wondering / questioning
		WEI11- Checking Consistency / Seeking justification (of a fact / plan option)
		WEI13- Simulating / Calculating Outcome (of a fact / plan option)
		WEI14- Weighing (Pros & Cons of an option) / Comparing (different options) / Pondering
	UNDERSTANDING	UND01- Realising (things become suddenly clear)
		UND02- Concluding / Synthesising
		UND03- Judging / Deeming / Considering
		UND11- Picturing / Making sense / Figuring out / Linking together
		UND12- Recognising / Making an analogy with (a known pattern)
		UND21- Considering as a suitable hypothesis / Taking as a basis for reasoning
		UND31- Failing to understand / picture
		UND32- Knowing not
		UND33- Judging unsatisfactory / false - Doubting
		UND34- Disapproving
A04- Emoting	E1 APPRAISING	APP11- Being alarmed by / Becoming aware of (discrepancy / irregularity in the situation)
	E2 EXPERIENCING	EXP11- Feeling / Experiencing (an affect
	E3 COPING	COP01- Urging (an immediate reaction) - Needing / Feeling a pressing need (to act)
		COP11- Tending to Avoid (Obj = Situation) = deter, distance, discard, …
		COP12- Tending to Accept (Obj = Situation) = submit, wait for, be patient, hope, ruminate, …
		COP14- Tending to Vent (Obj = Situation) = vent emotions, talk about events
		DIS11- Seeing in slow motion (things / others / oneself) / Slowing (time, sound) / suspending reality
		DIS12- Narrowing or reshaping (space)
		DIS13- Hyperfocusing (attention on a detail)
[2]		DIS14- Detaching oneself from reality / Derealising (the WOA or experience) / becoming spectator of one's own action
A05- Deciding	DECIDING	DEC11- Deciding / Choosing / Selecting (a plan / option)
		DEC22- Resolving finally (after some hesitation) to go for (a COA)
A06- Acting	PERFORMING	PRF11- Performing / Doing / Executing
		PRF13- Being / Standing in the world

Table 27 Taxonomy of Cognitive Acts (CogActs)

13.3.2. Cognitive objects (CogObj) : families, types, sub-types, and definitions

The sub-types, types and families of CogObjs are :

Family	CogObj	CogObjST (sub-type
00- LTM objects	ENCYCLOPAEDIA	RUL12- Moral Rule
		RUL13- Procedure / Regulation - Practical method
		SEM11- Stereotype
		SEM12- Theoretical Knowledge ; Mental Schema ; Model

		/ Association
	PERSONALITY	PAT11- Attitude (I-World Relating Readiness: Avoidance)
02- Attention Objects	ATTENTIONAL OBJECTS	STM11- Data maintained in Short-term memory
03- Affective objects	A1 SHOCK / SALIENCE	SAL11- Salience / Shock (discrepancy / irregularity / novelty / ...)
	A2 AFFECTS	AFF11- Affect: Emotion (Brief reaction: positive or negative)
		AFF12- Affect: Attraction / Affect (Momentary feeling / tendency)
		AFF21- Affect: Stress (Momentary crushing feeling of under-capability)
		AFF31- Affect: Fright / Stupor (Brief and irrepressible sentiment of imminent self-destruction and powerlessness, beyond fear)
04- Cognitive objects	REFLECTIONS	REF11- Inappropriateness of an action
		REF12- Things I will never do
05- Situational objects	SITUATION - COE / COA	SIT11- PICTURE: Mental Picture as pattern, conceptual representation or mathematical explanation
		SIT12- PICTURE: Mental Story as representation of dynamic historic development
		SIT13- EXPLANATION: Why the situation is what it was / The facts
		SIT14- RETROSPECTION: What could have happened (how the situation could have evolved)
		SIT15- PROSPECTIVE: What could happen (how the situation might evolve)
		SIT21- RISK: Inadequacy / Discrepancy (expectations // reality, facts // information...)
		SIT23- RISK: Severity of the situation (Nature, extent or number of threat / victims / risk, …)
		SIT24- RISK: Main / Most imminent danger / risk / incident
		SIT25- RISK: Anticipable subsequent incidents / risks
		SIT26- RISK: Risks inexistant / under control
		SIT33- PROGRESS: Gap to goals / motivations - Difficulties ahead
		SIT35- PROGRESS: End of the mission reached / Mission or step over
		SIT36- PROGRESS: Failure of the action / mission
		SIT41- CONDUCT: Adequacy of COA / COE
		SIT42- CONDUCT: Inadequacy of COA / COE
		SIT43- CONDUCT: Decisions made to conduct the next step of COA
		SIT44- CONDUCT: Time to act is appropriate
		SIT46- CONDUCT: Potential / Likely way out of trouble / to get results
		SIT51- CERTAINTY: Reality of the situation
		SIT61- FACTS: Facts / Figures
06- Action Regulator objects	ABILITIES	ABI21- Powerlessness
	ACTION PLAN	OPT11- Options for action : Plan / Procedure - Steps to take
		OPT13- Role Allocation for action
		OPT14- Route / Itinerary for action
	CONFIDENCE	CFD32- Low level of Trust (in someone / his words)
	LATITUDE – MARGINS	MAR11- Safety margin
		MAR12- Space margin
		MAR22- Resource on hand / Competent people available
		MAR51- Absence of margin / Difficulty
	STIMULATIONS	COL11- Collective intention

		DUT11- DUTY: What has to be done / The task to complete
		INT11- INTENTION: Goal / Expected or sought effect / Mission
		MOT12- MOTIVE: Perspective (WOA's / Mental Story's end / expected development)
		MOT15- MOTIVE: Justification (why in fine I choose to do sthg)
07- WOA Experience objects	OBJECTS	OBJ01- FEATURES - Young / Old - Tall / small
		OBJ01- OBJECT - One object in particular among several
		OBJ02- POSITION - Standing / Being gathered (somewhere)
		OBJ02- STANCE - Lying down / Sitting, Open / Closed, …
		OBJ02- STATE - Physical State
		OBJ03- TRAJECTORY - Where they are heading for / Which path they take
		OBJ10- ACTION - Joining / Going to attend to (sthg / someone) / Intervening
		OBJ11- ACTION - Approaching / Getting close to a place
		OBJ18- ACTION - Being about to leave
	OTHERS / ANIMALS	OTH01- FEATURES - Young / Old - Tall / small
		OTH01- IDENTITY - Name or details / Who that is
		OTH01- SOMEONE - Someone / An animal in particular among several
		OTH02- DETAIL - Eyes / …
		OTH02- POSITION - Standing / Being gathered (somewhere)
		OTH02- PRESENCE - Being absent somewhere
		OTH02- PRESENCE - Being there / somewhere
		OTH02- STANCE - Lying down / Sitting / Standing up…
		OTH02- STATE - Physical or emotional State
		OTH03- DIFFICULTIES - What it will take to achieve their goals
		OTH03- METHOD - How they do / will do their job
		OTH03- MISSION - What they are here for / What they have to do
		OTH03- TRAIL - Traces of past actions
		OTH03- TRAJECTORY - Where they are heading for / Which path they take
		OTH04- GEAR - Equipment / Clothing
		OTH04- LATITUDE - Margin of manoeuvre
		OTH04- SAFETY - Exposure to a threat / Potential damage
		OTH05- FATE - Accident / Story of what happened to the person / group
		OTH10- ACTION - Joining / Going to attend to (sthg / someone) / Intervening
		OTH11- ACTION - Approaching / Getting close to a place
		OTH12- ACTION - Arriving / Rejoining / Returning
		OTH13- ACTION - Leaving / Coming out
		OTH14- ACTION - Moving / Walking / Running / Driving
		OTH15- ACTION - Moving away / Distancing / Running away
		OTH17- ACTION - Boarding / Being carried away / transported / taken on board
		OTH30- ACTION - Holding / Wearing / Carrying sthg
		OTH31- ACTION - Realising / Executing / Doing sthg
		OTH32- ACTION - Changing direction / Switching course of action

		OTH33- ACTION - Failing / Missing / Wasting an opportunity
		OTH35- ACTION - Interacting / Cooperating / Teamworking
		OTH36- ACTION - Pausing / Freezing / Interrupting / holding up / stopping / staying
		OTH38- ACTION - Waiting / getting in waiting / Doing nothing / linger
		OTH39- ACTION - Restarting / Starting / Continuing
		OTH40- ACTION - Searching / Looking for (sthg) / Seeking / Watching
		OTH43- ACTION - Being intrusive / nosy / curious
		OTH44- ACTION - Ignoring / Not bothering / Not paying attention to sthg
		OTH52- ACTION - Taking a defensive stance / Trying to prevent
		OTH53- ACTION - Being affected / wounded
		OTH54- ACTION - Resisting / Protecting oneself / Seeking refuge
		OTH55- ACTION - Recovering
		OTH57- ACTION - Dying
		OTH58- ACTION - Being captured
		OTH61- ACTION - Threatening / Pausing a threat
		OTH62- ACTION - Knocking down / Putting down / Catching
		OTH63- ACTION - Preparing to attack
		OTH64- ACTION - Attacking / Destroying / Killing
		OTH65- ACTION - Fighting / Firing
		OTH67- ACTION - Protecting / Helping (others)
		OTH68- ACTION - Keeping under control
		OTH69- ACTION - Suffering
		OTH70- ACTION - Utterance : Keeping silent / Saying nothing / Mute
		OTH72- ACTION - Utterance : Question
		OTH73- ACTION - Utterance : Conversation (Information + Question)
		OTH74- ACTION - Utterance : Answer
		OTH75- ACTION - Utterance : Information / Opinion / Reporting - Message
		OTH76- ACTION - Utterance : Injunction / Order
		OTH77- ACTION - Utterance : Emotional expression : Yelling / Screaming
		OTH78- ACTION - Utterance : Emotional expression : Shouting - Insulting
		OTH79- ACTION - Utterance : Emotional expression : Emotion - Sentiment of defeat - Negative / depressed feelings
		OTH88- BEHAV - Fury, anger, shouting with anger
		OTH96- BEHAV - Calm
	SETTINGS	SET12- Zoning / Structuration of space / Configuration
		SET13- General Physical State
		SET14- Noise / Sounds
		SET21- Populating People and numbers / features
		SET22- Populating Objects and numbers / features
		SET32- Ambient Dangers - Incidents - Risks
	TIME	TIM21- Subjective Time: Length
08- Actions taken	SELF[288]	SLF02- POSITION - Standing / Being gathered (somewhere)
		SLF03- MISSION - What the subject is here for / What he has to do
		SLF03- TRAJECTORY - Where the subject is heading for / Which path he takes

SLF05- FATE - Accident / Story of what happened to the subject
SLF05- PAIN - Feeling of pain / being hurt / getting wounded
SLF10- ACTION - Joining / Going to attend to (sthg / someone) / Intervening
SLF12- ACTION - Arriving / Rejoining / Returning
SLF14- ACTION - Moving / Walking / Running / Driving
SLF16- ACTION - Following
SLF17- ACTION - Boarding / Being carried away / transported / taken on board
SLF32- ACTION - Changing direction / course of action
SLF38- ACTION - Waiting / getting in waiting / linger
SLF40- ACTION - Searching / Looking for (sthg) / Seeking / Watching
SLF45- ACTION - Checking / Verifying de visu
SLF68- ACTION - Keeping under control
SLF71- ACTION - Utterance : Interruption
SLF72- ACTION - Utterance : Question
SLF73- ACTION - Utterance : Conversation (Information + Question)
SLF74- ACTION - Utterance : Answer
SLF75- ACTION - Utterance : Information / Opinion / Reporting - Message
SLF76- ACTION - Utterance : Injunction / Order
SLF79- ACTION - Utterance : Emotional expression : Emotion - Sentiment of defeat - Negative / depressed feelings

Table 28 Taxonomy of Cognitive Objects (CogObj

13.3.3. Cognitive Operations (CogOp), or {CogAct ; CogObj} pairs

A total of 460 cognitive operations (CogOp) have been elicited in the study of Lieutenant A's case. Cognitive Operations are unseparable {CogAct ; CogObj} pairs. The types of CogOps elicited in Lieutenant A's case were formed of the following CogActs and CogObjs :

CogAct	CogObj
ATTENDING	ATTENTIONAL OBJECTS
	LATITUDE - MARGINS
	OTHERS / ANIMALS
	SELF
DECIDING	ACTION PLAN
E1 APPRAISING	A1 SHOCK / SALIENCE
E2 EXPERIENCING	A2 AFFECTS
E3 COPING	ABILITIES
	ACTION PLAN
	OBJECTS
	OTHERS / ANIMALS
	SELF
	SETTINGS
ELABORATING	ACTION PLAN
	STIMULATIONS
LEARNING	ENCYCLOPAEDIA
	PERSONALITY
ORIENTING	OTHERS / ANIMALS
	SELF

	SITUATION - COE / COA
	STIMULATIONS
PERCEIVING	OBJECTS
	OTHERS / ANIMALS
	SELF
	SETTINGS
PERFORMING	SELF
PRO/PARA-TENDING	SITUATION - COE / COA
REFLECTING	ACTION PLAN
	ATTENTIONAL OBJECTS
	LATITUDE - MARGINS
	OTHERS / ANIMALS
	REFLECTIONS
	SETTINGS
	SITUATION - COE / COA
REMEMBERING	ENCYCLOPAEDIA
	OBJECTS
STM KEEPING	OBJECTS
	OTHERS / ANIMALS
	SETTINGS
	SITUATION - COE / COA
	STIMULATIONS
UNDERSTANDING	CONFIDENCE
	ENCYCLOPAEDIA
	LATITUDE - MARGINS
	OTHERS / ANIMALS
	SITUATION - COE / COA
	STIMULATIONS
	TIME

Table 29 Taxonomy of Cognitive Operations (CogOps) at the type level

ANNEX 17 presents the more precise subtype-level cognitive operations found in Lieutenant A's case.

13.3.4. When did we assume the existence of CogOps ?

Beside what precedes, of the 460 CogOps we elicited :

- 319 CogOps involve CogActs with a "*CERTAIN*" status : the semantic analysis of Speech Clauses has suggested the occurrence of a CogOp beyond reasonable doubt[289].

- 141 CogOps involve CogActs with an "*ASSUMED*" status : the semantic analysis of Speech Clauses suggested either an "implied" narration of one or several CogActs[290], or we found a "gap" in the narration of the subject's cognitive experience. Then, a deliberate choice was made to "assume" the occurrence of CogActs, and therefore of the corresponding CogOps.

The number of *assumed* CogActs (and therefore CogOps) amounts to 30,65% of the total number of 460 CogOps. Assumed CogActs are :

Contribution to the total % of assumed CogActs	CogActs	% of CogActs assumed	NB of CogActs assumed	Out of NB of CogOps performed
17,02%	UNDERSTANDING	37,50%	24	64
14,89%	E1 APPRAISING	100,00%	21	21
11,35%	PERCEIVING	10,46%	16	153
11,35%	E2 EXPERIENCING	72,73%	16	22
8,51%	E3 COPING	42,86%	12	28
7,09%	PERFORMING	18,87%	10	53
5,67%	REMEMBERING	57,14%	8	14
4,96%	REFLECTING	25,00%	7	28
4,96%	DECIDING	24,14%	7	29
4,26%	ATTENDING	60,00%	6	10
3,55%	STM KEEPING	41,67%	5	12
2,13%	ORIENTING	17,65%	3	17
2,13%	LEARNING	75,00%	3	4
1,42%	ELABORATING	50,00%	2	4
0,71%	PRO/PARA-TENDING	100,00%	1	1
30,65%			**141**	**460**

Table 30 Percentage and distribution of assumed CogActs

A significant part of emotion-related CogActs (E1 APPRAISING, E2 EXPERIENCING, E3 COPING) were assumed (42,86% up to 100%), out of necessity as the example below shows.

An example of assumed affect-related CogActs is provided here with the cognigraph of Present Moment #05 :

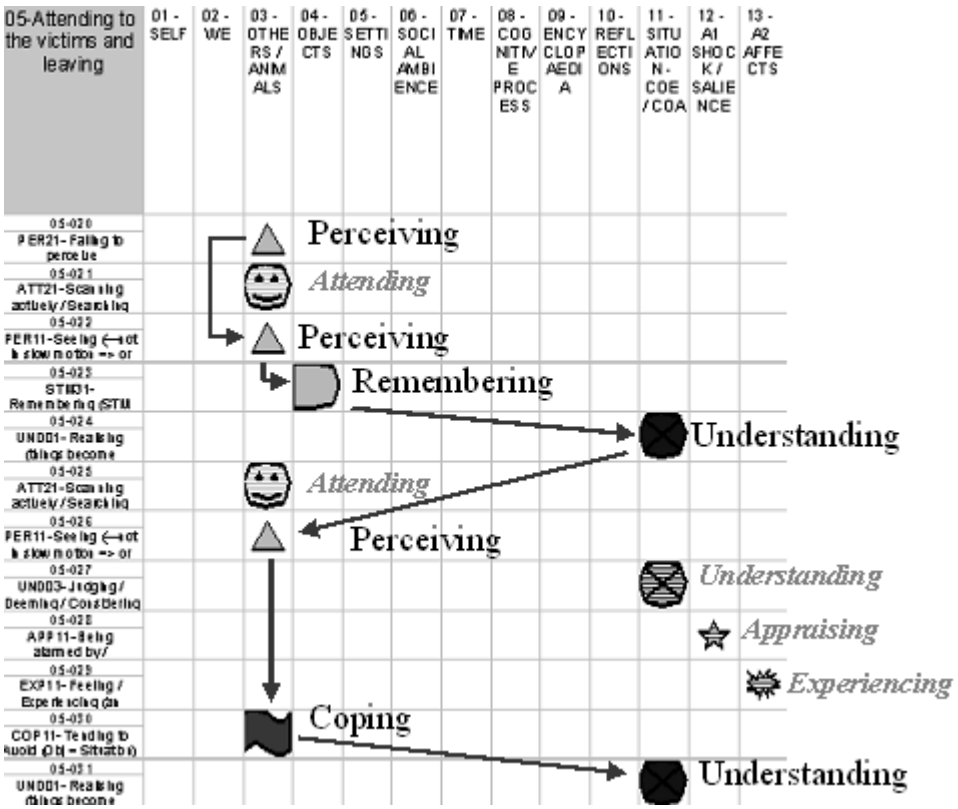


Figure 21 An example of a cognigraph and the choice to assume emotion-related CogOps (PM # 5)

In this example the assumptions we made (CogActs in italic) can be better understood if we consider only “CERTAIN” CogActs in the cognitive trajectory (plain icons linked by arrows) :

CogOp #	CogOp (sub-type = {$CogAct_{ST}$; $CogObj_{ST}$})	Speech Clause and translation to English	Interpretation
05-022	PER11- Seeing (---not in slow motion => or select Dissociate / see in slow motion---) / read - OTH02- STATE - Physical or emotional State	y'avait plus que euh- les ch'veux de- derrière, y'avait plus qu'les ch'veux derrière, donc scalpée complètement, que- que- on voyait l'crane "*she had only hair left on the back of her head, that is she was completely scalped, one could see her skull*"	he saw her scull made naked by scalping
05-023	STM31- Remembering (STM data) - OBJ01- OBJECT - One object in particular among several	quand j'suis arrivé, j'ai vu, j'ai aperçu sur une p'tite table (ns) sur une terrasse, y'avait une terrasse euh- devant l'pavillon, sur une table euh y avait euh- des ch'veux + parc'que quand j'suis arrivé “*when I was on the garden terrace about to enter the lounge there was hair on a small table*”	When he sees the woman has been scalped : - he remembers the hairs on the terrace table
05-024	UND01- Realising (things become suddenly clear) - SIT12- PICTURE: Mental Story as representation of dynamic historic development	quand j'suis arrivé, j'ai vu, j'ai aperçu sur une p'tite table (ns) sur une terrasse, y'avait une terrasse euh- devant l'pavillon, sur une table euh y avait euh- des ch'veux + parc'que quand j'suis arrivé “*when I was on the garden terrace about to enter the lounge there was hair on a small table*”	he understands / gets a clear picture of what must have happened, of the story
05-026	PER11- Seeing (---not in slow motion => or select Dissociate / see in slow motion---) / read - OTH02- STATE - Physical or emotional State	et donc euh- coupée euh-, et puis mordue un peu partout “*and also she is cut- hmmm- and bitten all over*”	"et puis" "and also" : after being overwhelmed by the sight of the victim's face / head he notices the other wounds, bites everywhere
05-030	COP11- Tending to Avoid (Obj = Situation) = deter, distance, discard, … - OTH02- STATE - Physical or emotional State	euh les esprits, on reste pas tout l'temps euh la vue sur euh- - sur cette jeune femme, là, mais euh-- “*hmm my spirit, I don’t keep watching hmm-- this young woman all the time, there, but hhmm—*“	- his coping mode is of an "escape" style / distract himself - he alternates focus of attention (once the dogs, once the victims) as a consequence

05-031	UND01- Realising (things become suddenly clear) - SIT24- RISK: Main / Most imminent danger / risk / incident	le plus grave, c'était surtout sa sa fille "*the worst case, it was her her daughter*"	- he realises that the daughter is more shocked than the mother

Table 31 "CERTAIN" CogOps in Present Moment # 5

Without any assumption, Lieutenant A's "CERTAIN" cognitive trajectory lacks "*cognitive consistency*" and makes one wonder how the subject's cognitive flow can spark a given "CERTAIN" CogOp without the meaning-creating mediation of the ASSUMED CogOps. For instance between CogOps 05-026 and 05-030 :

- In 05-026 Lieutenant A sees that the woman has been bitten and cut all over her body on top of being scalped.

- 05-030 shows a coping reaction of avoidance ("*I don't keep watching*") without the "*cognitive build up*" suggested by the "high-level model of the stressor → appraisal → coping → response process" presented in chapter 2. This model indicates that a coping reaction is associated with a stress / emotional reaction, itself following a negative appraisal of a stressor.

- Though Lieutenant A did not make any utterance suggesting the performance of the "missing" CogOps, it is deemed acceptable to assume them (05-027 to 05-029).

Assumptions were also made for REMEMBERING CogActs, based on the knowledge gained from my field study.

Assumptions about ATTENDING CogActs were based on the "logic" of the story. For instance at CogOp 05-021, when Lieutenant A says "*I couldn't see much*" we can assume a " ATT21- Scanning actively / Searching (for cues / expectations)" CogAct sub-type that itself falls under ATTENDING.

STM KEEPING CogActs are assumed in 41,67% of cases, as in CogOp 05-043 for instance when Lt A says " *because that was the only thing I had not yet seen*" that means that at this point he remembers his duty (attending to the dogs).

The case of "PRO/PARA-TENDING" CogActs (100% assumed) is different on all accounts :

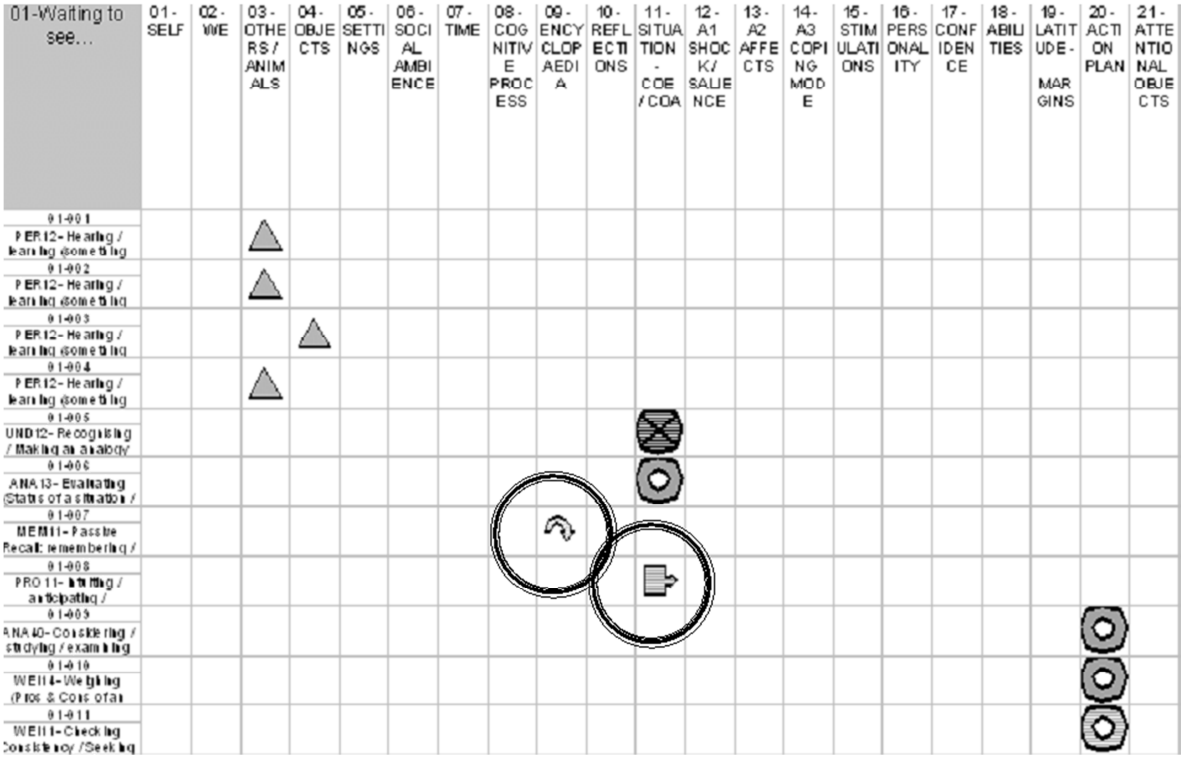


Figure 22 An ASSUMED anticipation CogOp in Present Moment # 1 (CogOp # 01-008)

- Only one such CogAct could be discerned (or rather inferred) in Lieutenant A's narrative, in PM # 1 (CogOp # 01-008).

- The assumed CogAct is likely as it refers to the most basic reasoning Lieutenant A should make in similar circumstances : thinking of what else might happen in following minutes :

CogOp #	CogOp (sub-type = {$CogAct_{ST}$; $CogObj_{ST}$})	Speech Clause and translation to English	Interpretation
01-008	PRO11- intuiting / anticipating / foreseeing / seeing as imminent / expecting - SIT15- PROSPECTIVE: What could happen (how the situation might evolve)	pour l'instant--- mordu par un chien c'est pas--- y'a p't'être d'autres choses plus graves "*for now… bitten by a dog, that's not… maybe there's something more serious to come up*"	he knows from experience more important cases may appear : there may be more serious stuff

Table 32 An ASSUMED anticipation CogOp in Present Moment # 1

As the picture shown in the example above also indicates, a "MEM11- Passive Recall: remembering / evoking"[291] REMEMBERING CogAct is assumed at CogOp # 01-007. It refers to the very likely remembrance of applicable regulations :

CogOp #	CogOp (sub-type = {$CogAct_{ST}$; $CogObj_{ST}$})	Speech Clause and translation to English	Interpretation
01-007	MEM11- Passive Recall: remembering / evoking - RUL13- Procedure / Regulation - Practical method	pour l'instant--- mordu par un chien c'est pas--- y'a p't'être d'autres choses plus graves "*for now… bitten by a dog, that's not… maybe there's something more serious to come up*"	he knows he is not supposed to intervene unless serious case

Table 33 An ASSUMED remembrance CogOp in PM # 1 (CogOp # 01-007)

13.4. Cognigraph

13.4.1. The descriptive process model of Lieutenant A's cognitive experience

Examples of PM-level cognigraphs have already been given. The cognigraph is the descriptive *process model* of Lieutenant A's cognitive experience during his intervention, i.e. the sequence of CogOps performed by the subject. As 460 CogOps were identified in Lieutenant A's narrative, a complete cognigraph would be too long to be presented in the pages of this report. Therefore, it is presented for each Present Moment in ANNEX 13[292].

13.4.2. Ambiguities in the detailed chronology of CogOps

The narrative does not always provide clues about the exact sequence of CogOps Lieutenant A performed as in the following example :

CI Experience Phase	Speech unit	CogOp #	Speech clause	CogAct	CogObj	CogActST	CogObjST
05 - Discovering the victims' fate	05 - Attending to the victims and leaving	05-006	assise en arrière, la tête en arrière "seated head bent backwards"	Perceiving	Others / animals	PER11- Seeing (---not in slow motion => or select Dissociate / see in slow motion---) / read	OTH02- STANCE - Lying down / Sitting / Standing up…
05 - Discovering the victims' fate	05 - Attending to the victims and leaving	05-007	une femme, une jeune femme "a woman, a young woman"	Perceiving	Others / animals	PER11- Seeing (---not in slow motion => or select Dissociate / see in slow motion---) / read	OTH01- FEATURES - Young / Old - Tall / small
05 - Discovering the victims' fate	05 - Attending to the victims and leaving	05-008	Elle {the mother}, elle parle, elle {the daughter} elle gémit "she (the mother), she speaks, the other (the daughter) she yells	Perceiving	Others / animals	PER12- Hearing / learning (something from someone, feedback from COA / COE)	OTH69- ACTION - Suffering
05 - Discovering the victims' fate	05 - Attending to the victims and leaving	05-009	Et, et une aut' femme également- par terre- "and, and another woman also- on the floor-"	Perceiving	Others / animals	PER11- Seeing (---not in slow motion => or select Dissociate / see in slow motion---) / read	OTH01- SOMEONE - Someone / An animal in particular among several

CI Experience Phase	Speech unit	CogOp #	Speech clause	CogAct	CogObj	CogActST	CogObjST
05 - Discovering the victims' fate	05 - Attending to the victims and leaving	05-010	qui euh--- qui n'était pas- qui n'avait pas grand chose, enfin pas grand chose, qui avait été, qui était choquée, quoi. Elle faisait un malaise, stressée euh- "who hhmm- who was not- who was not seriously hurt, well not seriously, she was shocked, she had a faint, stress"	Perceiving	Others / animals	PER11- Seeing (---not in slow motion => or select Dissociate / see in slow motion---) / read	OTH02- STATE - Physical or emotional State

Table 34 A series of PERCEIVING CogActs difficult to sequence

There is no evidence that perceptions occurred in the chosen sequence (05-006 to 05-010) and another ordering choice could have been made. When Lieutenant A validated the reordered sequence at the end of 2007, he did not notice any discrepancy with his actual experience. But this may mean he did not notice or did not deem important such details during his validation.

13.5. 460 cognitive operations

13.5.1. Detailed view (460 CogOps, with matching original speech clauses)

ANNEX 12 presents the full sequence of CogOps with the corresponding speech clauses (in French and English) from which they were drawn during semantic parsing. The following table presents only, as an example, the first three CogOps and their composition in termes of pairs of {CogAct ; CogObj} and of more detailed pairs of {CogActST ; CogObjST} :

Speech Unit / Story segment	Present Moment	CogOp #	Speech Clause and Translation	CogAct	Cog0bj	CogActST	CogObjST
01 - Doubts and economy	00 - Before it started	00-001	Ben, j'étais, j'étais au standard, au standard de la caserne "Well, I was at the station's switchboard"	performing	self	PRF13- Being / Standing in the world	SLF02- POSITION - Standing / Being gathered (somewhere)
01 - Doubts and economy	01 - Waiting to see…	01-001	là, et euh y'a un le stationnaire qui me dit que euh… " mon lieutenant, y'a le VSAV de <OTHER FIRE STATION> qui est parti euh pour une personne mordue par un ch… mordue par un rottweiler. "then and hhmm the call taker tells me : Lieutenant the <other station's> VSAV has gone for a person bitten by a rottweiler dog"	perceiving	others / animals	PER12- Hearing / learning (something from someone, feedback from COA / COE)	OTH75- ACTION - Utterance : Information / Opinion / Reporting - Message

Speech Unit / Story segment	Present Moment	CogOp #	Speech Clause and Translation	CogAct	Cog0bj	CogActST	CogObjST
01 - Doubts and economy	01 - Waiting to see…	01-002	là, et euh y'a un le stationnaire qui me dit que euh… " mon lieutenant, y'a le VSAV de <OTHER FIRE STATION> qui est parti euh pour une personne mordue par un ch… mordue par un rottweiler. "then and hhmm the call taker tells me : Lieutenant the <other station's> VSAV has gone for a person bitten by a rottweiler dog"	perceiving	others / animals	PER12- Hearing / learning (something from someone, feedback from COA / COE)	OTH05- FATE - Accident / Story of what happened to the person / group

Table 35 First three CogOps in Lieutenant A's case, with speech clauses

CogOps are assigned a sequential number like 01-002 : 01 represents the Present Moment in which the CogOp is found, and 002 is the sequential number of the CogOp within this PM.

13.5.2. A simplified view : 460 Decision Making Steps

In order to facilitate the reading and elaboration of the global decision network of Lieutenant A's experience, a more abstract DM Step was substituted to every CogOp.

ANNEX 12 presents the corresponding sequence of 460 DM Steps.

13.6. Decision networks : the shape of Lieutenant A's cognitive trajectories

This section presents decision networks calculated for the global episode (CogOp and DM Step based versions) and intermediate CI Experience Phase (CogOp-based version) levels.

Decision networks represent the phenotypic succession links between CogOps. The width of the arrows reflects the found frequency of each given phenotypic link.

First, we present the global CogOp-based decision network, and next the same global decision network is presented, but DM Step-based.

The comparison shows how DM Steps simplify the reading of the model. On another hand, it shows how abstraction diminishes the semantic content of each operation present in the model.

This is why decision networks for the intermediate (CI Experience Phase) and detailed (Present Moment) levels remain CogOp-based, in order to convey to the reader richer details of Lieutenant A's cognitive activity.

Frequencies were computed from the CogOp data set by the phenomenographic database.

The following decision networks are as good and usable by other researchers as data collection and processing were performed to a satisfactory standard of rigour.

The calculated frequencies are presented systematically after each graph.

Graphs do not show all found phenotypic links as they are too numerous and would have made graphs illegible. Therefore, only the links with a frequency of 9% and above, or those of particular interest are represented.

13.6.1. Global level : CogOp-based global decision network

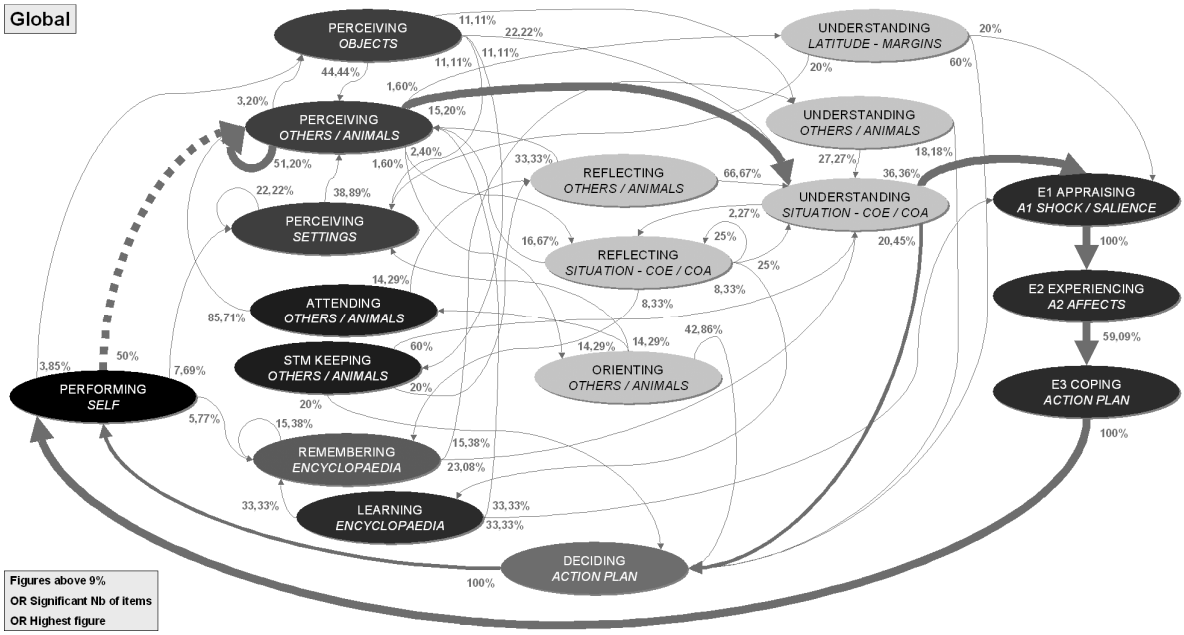


Figure 23 CogOp-based global decision network

Data :

GENOTYPIC COGOP {COGACT – COGOBJ}	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP {COGACT – COGOBJ}
ATTENDING - ATTENTIONAL OBJECTS	100,00%	REFLECTING - SITUATION - COE / COA
ATTENDING - LATITUDE - MARGINS	100,00%	PERCEIVING - OTHERS / ANIMALS
ATTENDING - OTHERS / ANIMALS	85,71%	PERCEIVING - OTHERS / ANIMALS
ATTENDING - OTHERS / ANIMALS	14,29%	REFLECTING - OTHERS / ANIMALS
ATTENDING - SELF	100,00%	UNDERSTANDING - TIME
DECIDING - ACTION PLAN	100,00%	PERFORMING - SELF
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	59,09%	E3 COPING - ACTION PLAN
E2 EXPERIENCING - A2 AFFECTS	13,64%	E3 COPING - OTHERS / ANIMALS
E2 EXPERIENCING - A2 AFFECTS	9,09%	E3 COPING - SETTINGS
E2 EXPERIENCING - A2 AFFECTS	4,55%	ATTENDING - OTHERS / ANIMALS
E2 EXPERIENCING - A2 AFFECTS	4,55%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	4,55%	E3 COPING - ABILITIES
E2 EXPERIENCING - A2 AFFECTS	4,55%	E3 COPING - SELF
E3 COPING - ABILITIES	100,00%	PERCEIVING - OTHERS / ANIMALS
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
E3 COPING - OBJECTS	100,00%	E3 COPING - OTHERS / ANIMALS
E3 COPING - OTHERS / ANIMALS	28,57%	E3 COPING - OTHERS / ANIMALS
E3 COPING - OTHERS / ANIMALS	28,57%	PERCEIVING - OTHERS / ANIMALS
E3 COPING - OTHERS / ANIMALS	14,29%	ATTENDING - LATITUDE - MARGINS
E3 COPING - OTHERS / ANIMALS	14,29%	E3 COPING - SELF
E3 COPING - OTHERS / ANIMALS	14,29%	UNDERSTANDING - SITUATION - COE / COA
E3 COPING - SELF	33,33%	E3 COPING - OBJECTS
E3 COPING - SELF	33,33%	PERCEIVING - SELF
E3 COPING - SELF	33,33%	PERFORMING - SELF
E3 COPING - SETTINGS	50,00%	E3 COPING - OTHERS / ANIMALS
E3 COPING - SETTINGS	50,00%	PERFORMING - SELF
ELABORATING - ACTION PLAN	100,00%	DECIDING - ACTION PLAN
ELABORATING - STIMULATIONS	100,00%	DECIDING - ACTION PLAN

GENOTYPIC COGOP {COGACT – COGOBJ}	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP {COGACT – COGOBJ}
LEARNING - ENCYCLOPAEDIA	33,33%	E1 APPRAISING - A1 SHOCK / SALIENCE
LEARNING - ENCYCLOPAEDIA	33,33%	PERCEIVING - OTHERS / ANIMALS
LEARNING - ENCYCLOPAEDIA	33,33%	REMEMBERING - ENCYCLOPAEDIA
LEARNING - PERSONALITY	100,00%	PERCEIVING - OTHERS / ANIMALS
ORIENTING - OTHERS / ANIMALS	42,86%	DECIDING - ACTION PLAN
ORIENTING - OTHERS / ANIMALS	14,29%	ATTENDING - OTHERS / ANIMALS
ORIENTING - OTHERS / ANIMALS	14,29%	ORIENTING - OTHERS / ANIMALS
ORIENTING - OTHERS / ANIMALS	14,29%	PERCEIVING - SETTINGS
ORIENTING - OTHERS / ANIMALS	14,29%	REFLECTING - LATITUDE - MARGINS
ORIENTING - SELF	33,33%	DECIDING - ACTION PLAN
ORIENTING - SELF	33,33%	ELABORATING - ACTION PLAN
ORIENTING - SELF	33,33%	STM KEEPING - STIMULATIONS
ORIENTING - SITUATION - COE / COA	75,00%	DECIDING - ACTION PLAN
ORIENTING - SITUATION - COE / COA	25,00%	PERCEIVING - OTHERS / ANIMALS
ORIENTING - STIMULATIONS	33,33%	ORIENTING - OTHERS / ANIMALS
ORIENTING - STIMULATIONS	33,33%	ORIENTING - SITUATION - COE / COA
ORIENTING - STIMULATIONS	33,33%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OBJECTS	44,44%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OBJECTS	22,22%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OBJECTS	11,11%	PERCEIVING - SETTINGS
PERCEIVING - OBJECTS	11,11%	STM KEEPING - OBJECTS
PERCEIVING - OBJECTS	11,11%	UNDERSTANDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	51,20%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	15,20%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	5,60%	UNDERSTANDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	3,20%	PERCEIVING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	3,20%	PERCEIVING - SETTINGS
PERCEIVING - OTHERS / ANIMALS	3,20%	REFLECTING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	2,40%	ATTENDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	2,40%	REFLECTING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	2,40%	STM KEEPING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	1,60%	DECIDING - ACTION PLAN
PERCEIVING - OTHERS / ANIMALS	1,60%	ORIENTING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	1,60%	UNDERSTANDING - LATITUDE - MARGINS
PERCEIVING - OTHERS / ANIMALS	0,80%	REFLECTING - ATTENTIONAL OBJECTS
PERCEIVING - OTHERS / ANIMALS	0,80%	REFLECTING - LATITUDE - MARGINS
PERCEIVING - OTHERS / ANIMALS	0,80%	REFLECTING - REFLECTIONS
PERCEIVING - OTHERS / ANIMALS	0,80%	REMEMBERING - ENCYCLOPAEDIA
PERCEIVING - OTHERS / ANIMALS	0,80%	REMEMBERING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	0,80%	STM KEEPING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	0,80%	UNDERSTANDING - CONFIDENCE
PERCEIVING - OTHERS / ANIMALS	0,80%	UNDERSTANDING - ENCYCLOPAEDIA
PERCEIVING - SELF	100,00%	E3 COPING - SELF
PERCEIVING - SETTINGS	38,89%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - SETTINGS	22,22%	PERCEIVING - SETTINGS
PERCEIVING - SETTINGS	5,56%	ORIENTING - SITUATION - COE / COA
PERCEIVING - SETTINGS	5,56%	PERCEIVING - OBJECTS
PERCEIVING - SETTINGS	5,56%	REFLECTING - ACTION PLAN
PERCEIVING - SETTINGS	5,56%	REFLECTING - SETTINGS
PERCEIVING - SETTINGS	5,56%	REMEMBERING - ENCYCLOPAEDIA
PERCEIVING - SETTINGS	5,56%	STM KEEPING - SITUATION - COE / COA
PERCEIVING - SETTINGS	5,56%	UNDERSTANDING - LATITUDE - MARGINS
PERFORMING - SELF	50,00%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	13,46%	PERFORMING - SELF
PERFORMING - SELF	7,69%	PERCEIVING - SETTINGS
PERFORMING - SELF	5,77%	REMEMBERING - ENCYCLOPAEDIA
PERFORMING - SELF	3,85%	PERCEIVING - OBJECTS

GENOTYPIC COGOP {COGACT – COGOBJ}	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP {COGACT – COGOBJ}
PERFORMING - SELF	3,85%	STM KEEPING - SITUATION - COE / COA
PERFORMING - SELF	1,92%	ATTENDING - ATTENTIONAL OBJECTS
PERFORMING - SELF	1,92%	ATTENDING - OTHERS / ANIMALS
PERFORMING - SELF	1,92%	ATTENDING - SELF
PERFORMING - SELF	1,92%	ELABORATING - STIMULATIONS
PERFORMING - SELF	1,92%	ORIENTING - STIMULATIONS
PERFORMING - SELF	1,92%	STM KEEPING - OTHERS / ANIMALS
PERFORMING - SELF	1,92%	STM KEEPING - SETTINGS
PERFORMING - SELF	1,92%	UNDERSTANDING - LATITUDE - MARGINS
PRO/PARA-TENDING - SITUATION - COE / COA	100,00%	REFLECTING - ACTION PLAN
REFLECTING - ACTION PLAN	50,00%	REFLECTING - ACTION PLAN
REFLECTING - ACTION PLAN	25,00%	ELABORATING - STIMULATIONS
REFLECTING - ACTION PLAN	25,00%	REMEMBERING - ENCYCLOPAEDIA
REFLECTING - ATTENTIONAL OBJECTS	100,00%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - LATITUDE - MARGINS	50,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
REFLECTING - LATITUDE - MARGINS	50,00%	UNDERSTANDING - LATITUDE - MARGINS
REFLECTING - OTHERS / ANIMALS	66,67%	UNDERSTANDING - SITUATION - COE / COA
REFLECTING - OTHERS / ANIMALS	33,33%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - REFLECTIONS	50,00%	LEARNING - PERSONALITY
REFLECTING - REFLECTIONS	50,00%	REFLECTING - REFLECTIONS
REFLECTING - SETTINGS	100,00%	UNDERSTANDING - OTHERS / ANIMALS
REFLECTING - SITUATION - COE / COA	25,00%	REFLECTING - SITUATION - COE / COA
REFLECTING - SITUATION - COE / COA	25,00%	UNDERSTANDING - SITUATION - COE / COA
REFLECTING - SITUATION - COE / COA	16,67%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - SITUATION - COE / COA	8,33%	LEARNING - ENCYCLOPAEDIA
REFLECTING - SITUATION - COE / COA	8,33%	ORIENTING - SELF
REFLECTING - SITUATION - COE / COA	8,33%	REMEMBERING - ENCYCLOPAEDIA
REFLECTING - SITUATION - COE / COA	8,33%	STM KEEPING - OTHERS / ANIMALS
REMEMBERING - ENCYCLOPAEDIA	23,08%	UNDERSTANDING - SITUATION - COE / COA
REMEMBERING - ENCYCLOPAEDIA	15,38%	REMEMBERING - ENCYCLOPAEDIA
REMEMBERING - ENCYCLOPAEDIA	15,38%	UNDERSTANDING - OTHERS / ANIMALS
REMEMBERING - ENCYCLOPAEDIA	7,69%	DECIDING - ACTION PLAN
REMEMBERING - ENCYCLOPAEDIA	7,69%	ORIENTING - OTHERS / ANIMALS
REMEMBERING - ENCYCLOPAEDIA	7,69%	ORIENTING - STIMULATIONS
REMEMBERING - ENCYCLOPAEDIA	7,69%	PERCEIVING - OBJECTS
REMEMBERING - ENCYCLOPAEDIA	7,69%	PRO/PARA-TENDING - SITUATION - COE / COA
REMEMBERING - ENCYCLOPAEDIA	7,69%	REFLECTING - SITUATION - COE / COA
REMEMBERING - OBJECTS	100,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - OBJECTS	100,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - OTHERS / ANIMALS	60,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - OTHERS / ANIMALS	20,00%	DECIDING - ACTION PLAN
STM KEEPING - OTHERS / ANIMALS	20,00%	REFLECTING - OTHERS / ANIMALS
STM KEEPING - SETTINGS	100,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - SITUATION - COE / COA	66,67%	REFLECTING - SITUATION - COE / COA
STM KEEPING - SITUATION - COE / COA	33,33%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - STIMULATIONS	100,00%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - CONFIDENCE	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - ENCYCLOPAEDIA	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - LATITUDE - MARGINS	60,00%	DECIDING - ACTION PLAN
UNDERSTANDING - LATITUDE - MARGINS	20,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - LATITUDE - MARGINS	20,00%	PERCEIVING - SETTINGS
UNDERSTANDING - OTHERS / ANIMALS	27,27%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - OTHERS / ANIMALS	18,18%	DECIDING - ACTION PLAN
UNDERSTANDING - OTHERS / ANIMALS	9,09%	ORIENTING - OTHERS / ANIMALS
UNDERSTANDING - OTHERS / ANIMALS	9,09%	PERCEIVING - OBJECTS
UNDERSTANDING - OTHERS / ANIMALS	9,09%	PERCEIVING - OTHERS / ANIMALS

GENOTYPIC COGOP {COGACT – COGOBJ}	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP {COGACT – COGOBJ}
UNDERSTANDING - OTHERS / ANIMALS	9,09%	PERCEIVING - SETTINGS
UNDERSTANDING - OTHERS / ANIMALS	9,09%	REFLECTING - SITUATION - COE / COA
UNDERSTANDING - OTHERS / ANIMALS	9,09%	REMEMBERING - ENCYCLOPAEDIA
UNDERSTANDING - SITUATION - COE / COA	36,36%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - SITUATION - COE / COA	20,45%	DECIDING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	6,82%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	4,55%	LEARNING - ENCYCLOPAEDIA
UNDERSTANDING - SITUATION - COE / COA	4,55%	ORIENTING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	4,55%	PERCEIVING - SETTINGS
UNDERSTANDING - SITUATION - COE / COA	4,55%	REMEMBERING - ENCYCLOPAEDIA
UNDERSTANDING - SITUATION - COE / COA	2,27%	ATTENDING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	2,27%	E3 COPING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	2,27%	ELABORATING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	2,27%	ORIENTING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	2,27%	ORIENTING - SELF
UNDERSTANDING - SITUATION - COE / COA	2,27%	REFLECTING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	2,27%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	2,27%	UNDERSTANDING - STIMULATIONS
UNDERSTANDING - STIMULATIONS	100,00%	ORIENTING - SELF
UNDERSTANDING - TIME	100,00%	ORIENTING - STIMULATIONS

13.6.2. Global level : DM Step-based global decision network

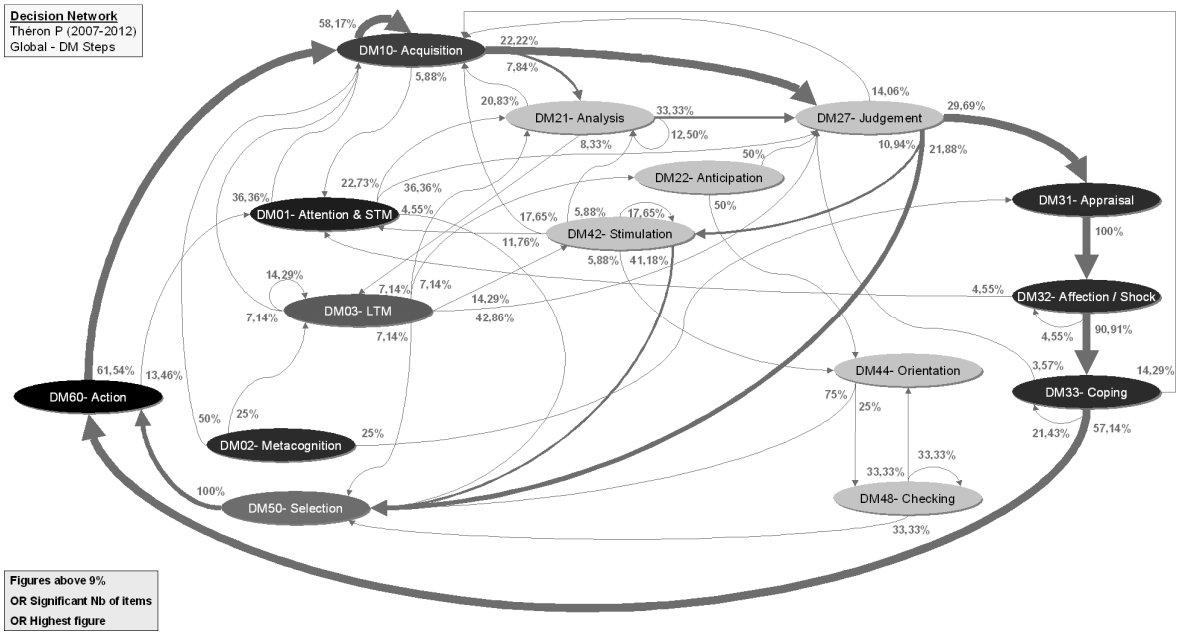


Figure 24 DM Step based global decision network

Data :

GENOTYPIC DM Step	FREQ OF PHENOTYPIC DM Step →	FOLLOWED BY PHENOTYPIC DM Step
DM01- Attention & STM	36,36%	DM27- Judgement
DM01- Attention & STM	36,36%	DM10- Acquisition
DM01- Attention & STM	22,73%	DM21- Analysis
DM01- Attention & STM	4,55%	DM50- Selection
DM02- Metacognition	50,00%	DM10- Acquisition
DM02- Metacognition	25,00%	DM03- LTM
DM02- Metacognition	25,00%	DM31- Appraisal
DM03- LTM	42,86%	DM27- Judgement
DM03- LTM	14,29%	DM03- LTM
DM03- LTM	14,29%	DM42- Stimulation (Motivation / Intention)
DM03- LTM	7,14%	DM10- Acquisition
DM03- LTM	7,14%	DM50- Selection
DM03- LTM	7,14%	DM21- Analysis
DM03- LTM	7,14%	DM22- Anticipation (SA)
DM10- Acquisition	58,17%	DM10- Acquisition
DM10- Acquisition	22,22%	DM27- Judgement
DM10- Acquisition	7,84%	DM21- Analysis
DM10- Acquisition	5,88%	DM01- Attention & STM
DM10- Acquisition	1,96%	DM42- Stimulation (Motivation / Intention)
DM10- Acquisition	1,96%	DM03- LTM
DM10- Acquisition	1,31%	DM50- Selection
DM10- Acquisition	0,65%	DM33- Coping
DM21- Analysis	33,33%	DM27- Judgement
DM21- Analysis	20,83%	DM10- Acquisition
DM21- Analysis	12,50%	DM21- Analysis
DM21- Analysis	8,33%	DM02- Metacognition
DM21- Analysis	8,33%	DM03- LTM
DM21- Analysis	4,17%	DM22- Anticipation (SA)
DM21- Analysis	4,17%	DM01- Attention & STM
DM21- Analysis	4,17%	DM48- Checking (consistency / applicability / efficiency / outcome)
DM21- Analysis	4,17%	DM31- Appraisal
DM22- Anticipation (SA)	50,00%	DM44- Orientation (Action Design)
DM22- Anticipation (SA)	50,00%	DM27- Judgement

GENOTYPIC DM Step	FREQ OF PHENOTYPIC DM Step →	FOLLOWED BY PHENOTYPIC DM Step
DM27- Judgement	29,69%	DM31- Appraisal
DM27- Judgement	21,88%	DM50- Selection
DM27- Judgement	14,06%	DM10- Acquisition
DM27- Judgement	10,94%	DM42- Stimulation (Motivation / Intention)
DM27- Judgement	7,81%	DM27- Judgement
DM27- Judgement	4,69%	DM03- LTM
DM27- Judgement	3,13%	DM21- Analysis
DM27- Judgement	3,13%	DM02- Metacognition
DM27- Judgement	1,56%	DM01- Attention & STM
DM27- Judgement	1,56%	DM33- Coping
DM27- Judgement	1,56%	DM44- Orientation (Action Design)
DM31- Appraisal	100,00%	DM32- Affection / Shock
DM32- Affection / Shock	90,91%	DM33- Coping
DM32- Affection / Shock	4,55%	DM32- Affection / Shock
DM32- Affection / Shock	4,55%	DM01- Attention & STM
DM33- Coping	57,14%	DM60- Action
DM33- Coping	21,43%	DM33- Coping
DM33- Coping	14,29%	DM10- Acquisition
DM33- Coping	3,57%	DM27- Judgement
DM33- Coping	3,57%	DM01- Attention & STM
DM42- Stimulation (Motivation / Intention)	41,18%	DM50- Selection
DM42- Stimulation (Motivation / Intention)	17,65%	DM10- Acquisition
DM42- Stimulation (Motivation / Intention)	17,65%	DM42- Stimulation (Motivation / Intention)
DM42- Stimulation (Motivation / Intention)	11,76%	DM01- Attention & STM
DM42- Stimulation (Motivation / Intention)	5,88%	DM44- Orientation (Action Design
DM42- Stimulation (Motivation / Intention)	5,88%	DM21- Analysis
DM44- Orientation (Action Design)	75,00%	DM50- Selection
DM44- Orientation (Action Design)	25,00%	DM48- Checking (consistency / applicability / efficiency / outcome)
DM48- Checking (consistency / applicability / efficiency / outcome)	33,33%	DM44- Orientation (Action Design)
DM48- Checking (consistency / applicability / efficiency / outcome)	33,33%	DM48- Checking (consistency / applicability / efficiency / outcome)
DM48- Checking (consistency / applicability / efficiency / outcome)	33,33%	DM50- Selection
DM50- Selection	100,00%	DM60- Action
DM60- Action	61,54%	DM10- Acquisition
DM60- Action	13,46%	DM60- Action
DM60- Action	13,46%	DM01- Attention & STM
DM60- Action	5,77%	DM03- LTM
DM60- Action	3,85%	DM42- Stimulation (Motivation / Intention)
DM60- Action	1,92%	DM27- Judgement

13.6.3. Intermediate level : 0 Ante-CI experience phase

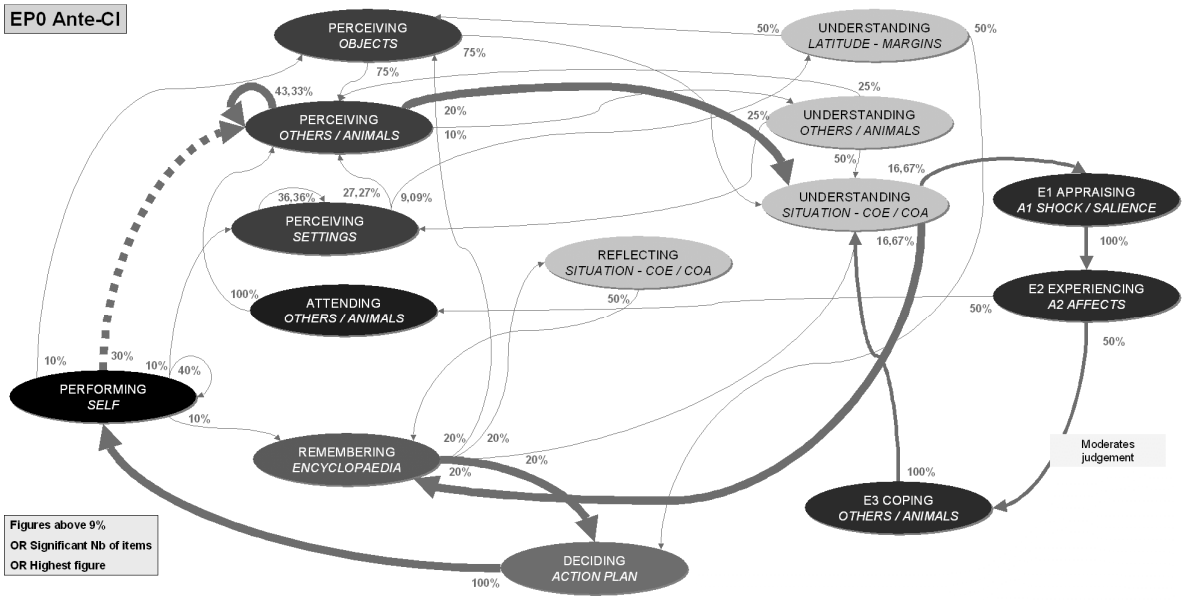


Figure 25 CogOp-based decision network of experience phase : 0 Ante-CI

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
ATTENDING - OTHERS / ANIMALS	100,00%	PERCEIVING - OTHERS / ANIMALS
DECIDING - ACTION PLAN	100,00%	PERFORMING - SELF
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	50,00%	ATTENDING - OTHERS / ANIMALS
E2 EXPERIENCING - A2 AFFECTS	50,00%	E3 COPING - OTHERS / ANIMALS
E3 COPING - OTHERS / ANIMALS	100,00%	UNDERSTANDING - SITUATION - COE / COA
ELABORATING - ACTION PLAN	100,00%	DECIDING - ACTION PLAN
ELABORATING - STIMULATIONS	100,00%	DECIDING - ACTION PLAN
ORIENTING - OTHERS / ANIMALS	100,00%	PERCEIVING - SETTINGS
ORIENTING - SELF	33,33%	DECIDING - ACTION PLAN
ORIENTING - SELF	33,33%	ELABORATING - ACTION PLAN
ORIENTING - SELF	33,33%	STM KEEPING - STIMULATIONS
PERCEIVING - OBJECTS	75,00%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OBJECTS	25,00%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	43,33%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	20,00%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	10,00%	UNDERSTANDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	6,67%	PERCEIVING - SETTINGS
PERCEIVING - OTHERS / ANIMALS	3,33%	ATTENDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	3,33%	ORIENTING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	3,33%	PERCEIVING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	3,33%	REFLECTING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	3,33%	STM KEEPING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	3,33%	UNDERSTANDING - LATITUDE - MARGINS
PERCEIVING - SETTINGS	36,36%	PERCEIVING - SETTINGS
PERCEIVING - SETTINGS	27,27%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - SETTINGS	9,09%	PERCEIVING - OBJECTS
PERCEIVING - SETTINGS	9,09%	REFLECTING - ACTION PLAN
PERCEIVING - SETTINGS	9,09%	REFLECTING - SETTINGS

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
PERCEIVING - SETTINGS	9,09%	UNDERSTANDING - LATITUDE - MARGINS
PERFORMING - SELF	40,00%	PERFORMING - SELF
PERFORMING - SELF	30,00%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	10,00%	PERCEIVING - OBJECTS
PERFORMING - SELF	10,00%	PERCEIVING - SETTINGS
PERFORMING - SELF	10,00%	REMEMBERING - ENCYCLOPAEDIA
PRO/PARA-TENDING - SITUATION - COE / COA	100,00%	REFLECTING - ACTION PLAN
REFLECTING - ACTION PLAN	50,00%	REFLECTING - ACTION PLAN
REFLECTING - ACTION PLAN	25,00%	ELABORATING - STIMULATIONS
REFLECTING - ACTION PLAN	25,00%	REMEMBERING - ENCYCLOPAEDIA
REFLECTING - OTHERS / ANIMALS	100,00%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - SETTINGS	100,00%	UNDERSTANDING - OTHERS / ANIMALS
REFLECTING - SITUATION - COE / COA	50,00%	ORIENTING - SELF
REFLECTING - SITUATION - COE / COA	50,00%	REMEMBERING - ENCYCLOPAEDIA
REMEMBERING - ENCYCLOPAEDIA	20,00%	DECIDING - ACTION PLAN
REMEMBERING - ENCYCLOPAEDIA	20,00%	PERCEIVING - OBJECTS
REMEMBERING - ENCYCLOPAEDIA	20,00%	PRO/PARA-TENDING - SITUATION - COE / COA
REMEMBERING - ENCYCLOPAEDIA	20,00%	REFLECTING - SITUATION - COE / COA
REMEMBERING - ENCYCLOPAEDIA	20,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - OBJECTS	100,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - STIMULATIONS	100,00%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - LATITUDE - MARGINS	50,00%	DECIDING - ACTION PLAN
UNDERSTANDING - LATITUDE - MARGINS	50,00%	PERCEIVING - SETTINGS
UNDERSTANDING - OTHERS / ANIMALS	50,00%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - OTHERS / ANIMALS	25,00%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - OTHERS / ANIMALS	25,00%	PERCEIVING - SETTINGS
UNDERSTANDING - SITUATION - COE / COA	16,67%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - SITUATION - COE / COA	16,67%	REMEMBERING - ENCYCLOPAEDIA
UNDERSTANDING - SITUATION - COE / COA	8,33%	ATTENDING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	8,33%	DECIDING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	8,33%	ELABORATING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	8,33%	ORIENTING - SELF
UNDERSTANDING - SITUATION - COE / COA	8,33%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	8,33%	PERCEIVING - SETTINGS
UNDERSTANDING - SITUATION - COE / COA	8,33%	REFLECTING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	8,33%	UNDERSTANDING - STIMULATIONS
UNDERSTANDING - STIMULATIONS	100,00%	ORIENTING - SELF

13.6.4. Intermediate level : 1 Pre-CI signals phase

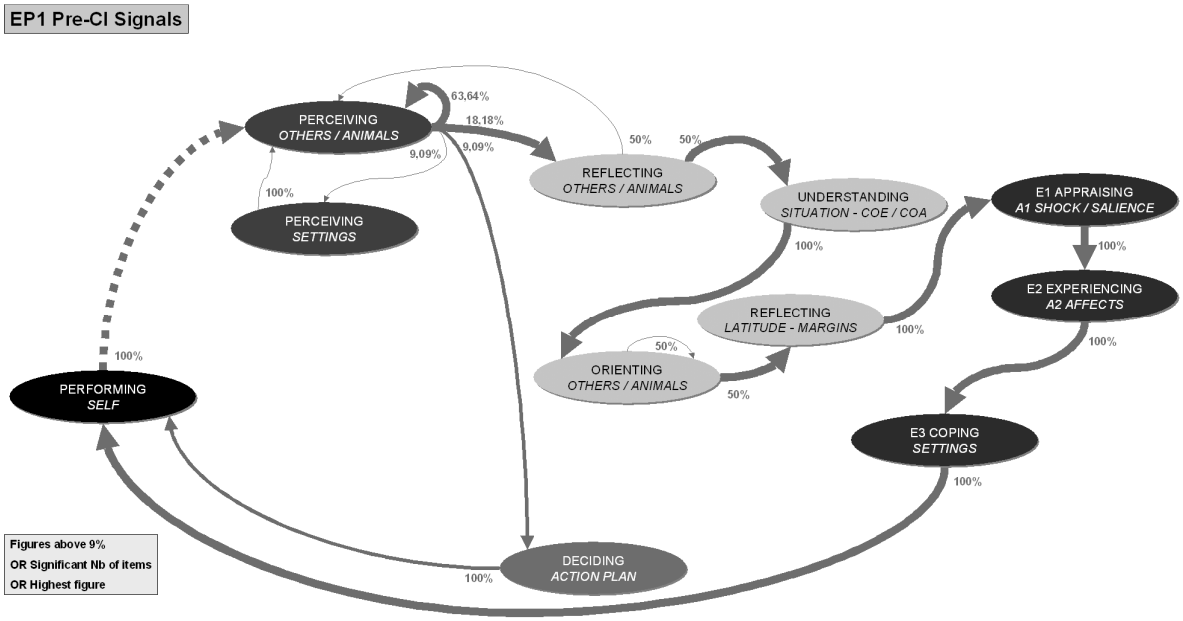


Figure 26 CogOp-based decision network of experience phase : 1 Pre-CI signals

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
DECIDING - ACTION PLAN	100,00%	PERFORMING - SELF
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	100,00%	E3 COPING - SETTINGS
E3 COPING - SETTINGS	100,00%	PERFORMING - SELF
ORIENTING - OTHERS / ANIMALS	50,00%	ORIENTING - OTHERS / ANIMALS
ORIENTING - OTHERS / ANIMALS	50,00%	REFLECTING - LATITUDE - MARGINS
PERCEIVING - OTHERS / ANIMALS	63,64%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	18,18%	REFLECTING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	9,09%	DECIDING - ACTION PLAN
PERCEIVING - OTHERS / ANIMALS	9,09%	PERCEIVING - SETTINGS
PERCEIVING - SETTINGS	100,00%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	100,00%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - LATITUDE - MARGINS	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
REFLECTING - OTHERS / ANIMALS	50,00%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - OTHERS / ANIMALS	50,00%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	100,00%	ORIENTING - OTHERS / ANIMALS

13.6.5. Intermediate level : 2 Pre-CI tension phase

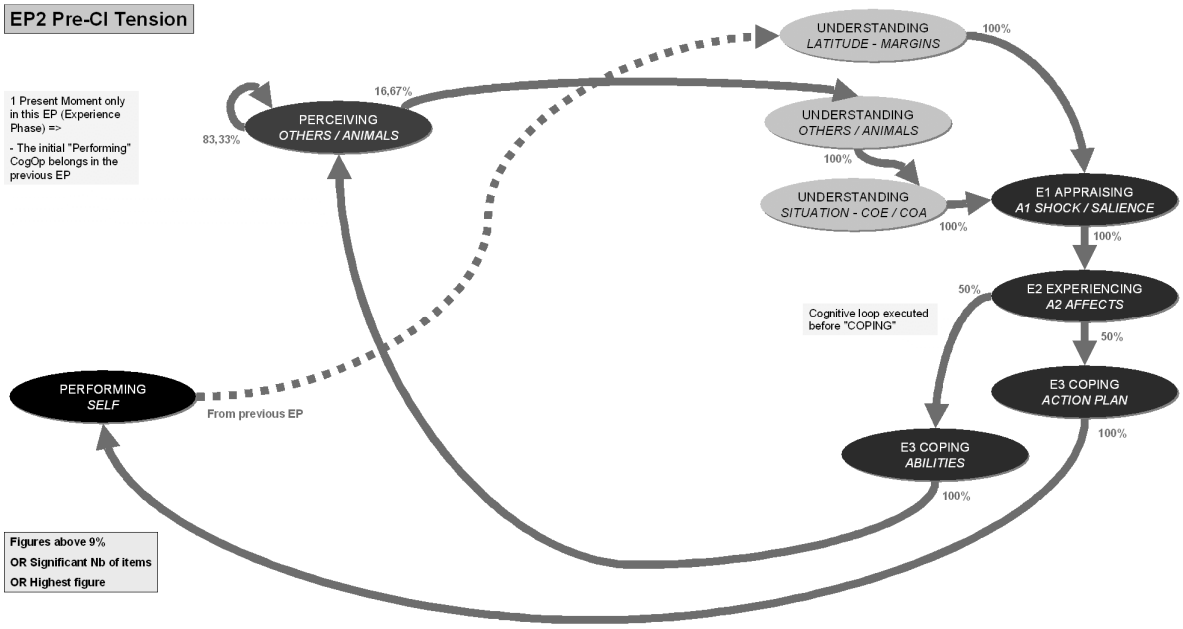


Figure 27 CogOp-based decision network of experience phase : 2 Pre-CI tension

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	50,00%	E3 COPING - ABILITIES
E2 EXPERIENCING - A2 AFFECTS	50,00%	E3 COPING - ACTION PLAN
E3 COPING - ABILITIES	100,00%	PERCEIVING - OTHERS / ANIMALS
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
PERCEIVING - OTHERS / ANIMALS	83,33%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	16,67%	UNDERSTANDING - OTHERS / ANIMALS
UNDERSTANDING - LATITUDE - MARGINS	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - OTHERS / ANIMALS	100,00%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE

13.6.6. Intermediate level : 3 CI Trauma Exposure phase

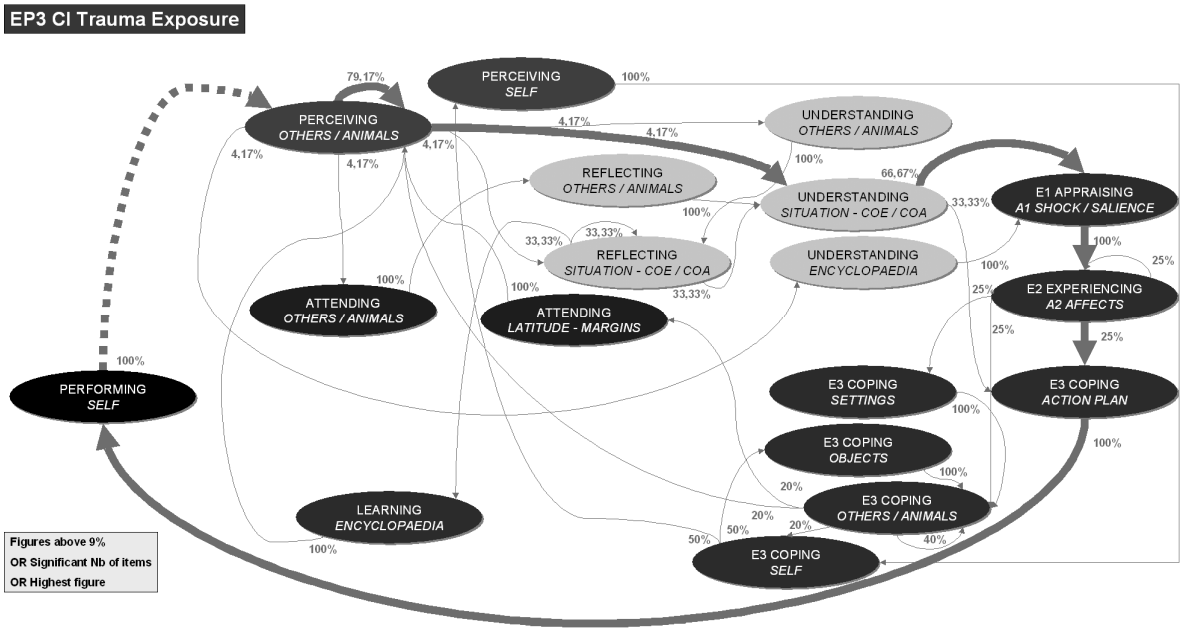


Figure 28 CogOp-based decision network of experience phase : 3 CI Trauma Exposure

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
ATTENDING - LATITUDE - MARGINS	100,00%	PERCEIVING - OTHERS / ANIMALS
ATTENDING - OTHERS / ANIMALS	100,00%	REFLECTING - OTHERS / ANIMALS
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	25,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	25,00%	E3 COPING - ACTION PLAN
E2 EXPERIENCING - A2 AFFECTS	25,00%	E3 COPING - OTHERS / ANIMALS
E2 EXPERIENCING - A2 AFFECTS	25,00%	E3 COPING - SETTINGS
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
E3 COPING - OBJECTS	100,00%	E3 COPING - OTHERS / ANIMALS
E3 COPING - OTHERS / ANIMALS	40,00%	E3 COPING - OTHERS / ANIMALS
E3 COPING - OTHERS / ANIMALS	20,00%	ATTENDING - LATITUDE - MARGINS
E3 COPING - OTHERS / ANIMALS	20,00%	E3 COPING - SELF
E3 COPING - OTHERS / ANIMALS	20,00%	PERCEIVING - OTHERS / ANIMALS
E3 COPING - SELF	50,00%	E3 COPING - OBJECTS
E3 COPING - SELF	50,00%	PERCEIVING - SELF
E3 COPING - SETTINGS	100,00%	E3 COPING - OTHERS / ANIMALS
LEARNING - ENCYCLOPAEDIA	100,00%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	79,17%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	4,17%	ATTENDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	4,17%	REFLECTING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	4,17%	UNDERSTANDING - ENCYCLOPAEDIA
PERCEIVING - OTHERS / ANIMALS	4,17%	UNDERSTANDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	4,17%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - SELF	100,00%	E3 COPING - SELF
PERFORMING - SELF	100,00%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - OTHERS / ANIMALS	100,00%	UNDERSTANDING - SITUATION - COE / COA
REFLECTING - SITUATION - COE / COA	33,33%	LEARNING - ENCYCLOPAEDIA
REFLECTING - SITUATION - COE / COA	33,33%	REFLECTING - SITUATION - COE / COA

REFLECTING - SITUATION - COE / COA	33,33%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - ENCYCLOPAEDIA	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - OTHERS / ANIMALS	100,00%	REFLECTING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	66,67%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - SITUATION - COE / COA	33,33%	E3 COPING - ACTION PLAN

13.6.7. Intermediate level : 4 CI Post-Tension phase

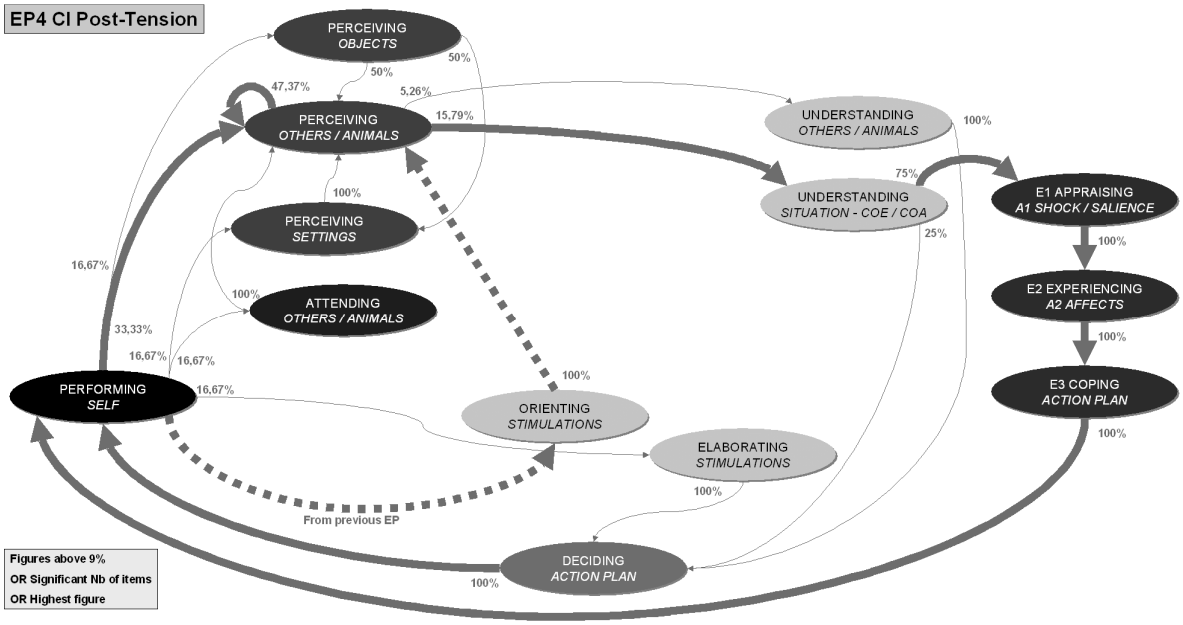


Figure 29 CogOp-based decision network of experience phase : 3 CI Trauma Exposure

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
ATTENDING - OTHERS / ANIMALS	100,00%	PERCEIVING - OTHERS / ANIMALS
DECIDING - ACTION PLAN	100,00%	PERFORMING - SELF
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	100,00%	E3 COPING - ACTION PLAN
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
ELABORATING - STIMULATIONS	100,00%	DECIDING - ACTION PLAN
LEARNING - PERSONALITY	100,00%	PERCEIVING - OTHERS / ANIMALS
ORIENTING - STIMULATIONS	100,00%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OBJECTS	50,00%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OBJECTS	50,00%	PERCEIVING - SETTINGS
PERCEIVING - OTHERS / ANIMALS	47,37%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	15,79%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	5,26%	DECIDING - ACTION PLAN
PERCEIVING - OTHERS / ANIMALS	5,26%	PERCEIVING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	5,26%	PERCEIVING - SETTINGS
PERCEIVING - OTHERS / ANIMALS	5,26%	REFLECTING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	5,26%	REFLECTING - REFLECTIONS
PERCEIVING - OTHERS / ANIMALS	5,26%	REFLECTING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	5,26%	UNDERSTANDING - OTHERS / ANIMALS
PERCEIVING - SETTINGS	100,00%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	33,33%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	16,67%	ATTENDING - OTHERS / ANIMALS
PERFORMING - SELF	16,67%	ELABORATING - STIMULATIONS
PERFORMING - SELF	16,67%	PERCEIVING - OBJECTS
PERFORMING - SELF	16,67%	PERCEIVING - SETTINGS

REFLECTING - OTHERS / ANIMALS	100,00%	UNDERSTANDING - SITUATION - COE / COA
REFLECTING - REFLECTIONS	50,00%	LEARNING - PERSONALITY
REFLECTING - REFLECTIONS	50,00%	REFLECTING - REFLECTIONS
REFLECTING - SITUATION - COE / COA	100,00%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - OTHERS / ANIMALS	100,00%	DECIDING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	75,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - SITUATION - COE / COA	25,00%	DECIDING - ACTION PLAN

13.6.8. Intermediate level : 5 CI Post-Relief phase

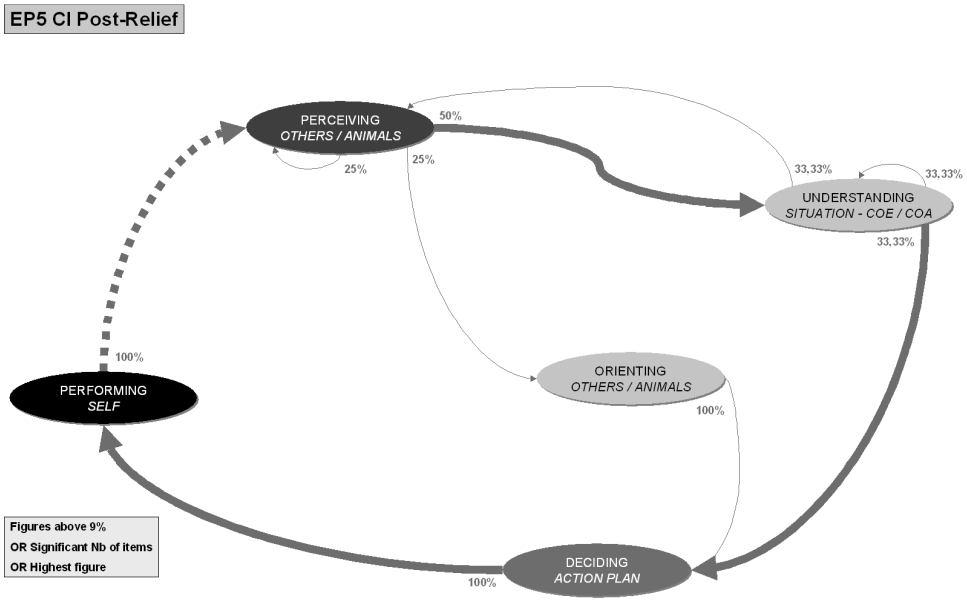


Figure 30 CogOp-based decision network of experience phase : 5 CI Post-Relief phase

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
DECIDING - ACTION PLAN	100,00%	PERFORMING - SELF
ORIENTING - OTHERS / ANIMALS	100,00%	DECIDING - ACTION PLAN
PERCEIVING - OTHERS / ANIMALS	50,00%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	25,00%	ORIENTING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	25,00%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	100,00%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	33,33%	DECIDING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	33,33%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	33,33%	UNDERSTANDING - SITUATION - COE / COA

13.6.9. Intermediate level : 6 CI Post-Venting phase

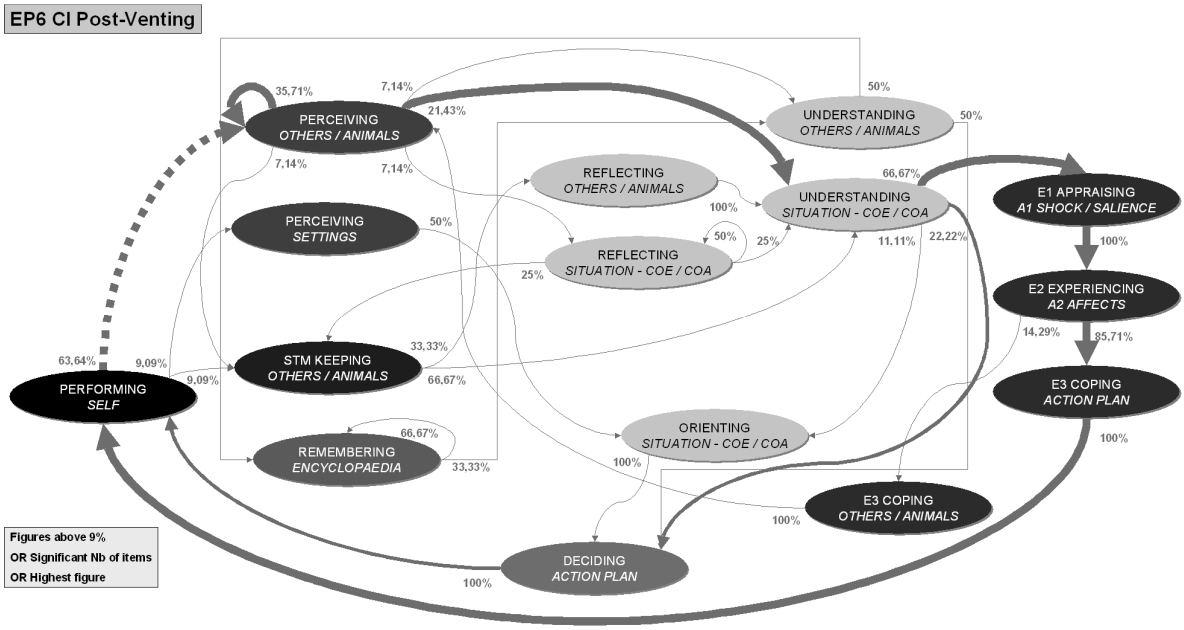


Figure 31 CogOp-based decision network of experience phase : 6 CI Post-Venting

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
DECIDING - ACTION PLAN	100,00%	PERFORMING - SELF
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	85,71%	E3 COPING - ACTION PLAN
E2 EXPERIENCING - A2 AFFECTS	14,29%	E3 COPING - OTHERS / ANIMALS
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
E3 COPING - OTHERS / ANIMALS	100,00%	PERCEIVING - OTHERS / ANIMALS
ORIENTING - SITUATION - COE / COA	100,00%	DECIDING - ACTION PLAN
PERCEIVING - OTHERS / ANIMALS	35,71%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	21,43%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	7,14%	REFLECTING - ATTENTIONAL OBJECTS
PERCEIVING - OTHERS / ANIMALS	7,14%	REFLECTING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	7,14%	REMEMBERING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	7,14%	STM KEEPING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	7,14%	UNDERSTANDING - CONFIDENCE
PERCEIVING - OTHERS / ANIMALS	7,14%	UNDERSTANDING - OTHERS / ANIMALS
PERCEIVING - SETTINGS	50,00%	ORIENTING - SITUATION - COE / COA
PERCEIVING - SETTINGS	50,00%	STM KEEPING - SITUATION - COE / COA
PERFORMING - SELF	63,64%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	9,09%	PERCEIVING - SETTINGS
PERFORMING - SELF	9,09%	PERFORMING - SELF
PERFORMING - SELF	9,09%	STM KEEPING - OTHERS / ANIMALS
PERFORMING - SELF	9,09%	STM KEEPING - SITUATION - COE / COA
REFLECTING - ATTENTIONAL OBJECTS	100,00%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - OTHERS / ANIMALS	100,00%	UNDERSTANDING - SITUATION - COE / COA
REFLECTING - SITUATION - COE / COA	50,00%	REFLECTING - SITUATION - COE / COA

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
REFLECTING - SITUATION - COE / COA	25,00%	STM KEEPING - OTHERS / ANIMALS
REFLECTING - SITUATION - COE / COA	25,00%	UNDERSTANDING - SITUATION - COE / COA
REMEMBERING - ENCYCLOPAEDIA	66,67%	REMEMBERING - ENCYCLOPAEDIA
REMEMBERING - ENCYCLOPAEDIA	33,33%	UNDERSTANDING - OTHERS / ANIMALS
REMEMBERING - OBJECTS	100,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - OTHERS / ANIMALS	66,67%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - OTHERS / ANIMALS	33,33%	REFLECTING - OTHERS / ANIMALS
STM KEEPING - SITUATION - COE / COA	50,00%	REFLECTING - SITUATION - COE / COA
STM KEEPING - SITUATION - COE / COA	50,00%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - CONFIDENCE	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - OTHERS / ANIMALS	50,00%	DECIDING - ACTION PLAN
UNDERSTANDING - OTHERS / ANIMALS	50,00%	REMEMBERING - ENCYCLOPAEDIA
UNDERSTANDING - SITUATION - COE / COA	66,67%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - SITUATION - COE / COA	22,22%	DECIDING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	11,11%	ORIENTING - SITUATION - COE / COA

13.6.10. Intermediate level : 7 CI Post-Resumption phase

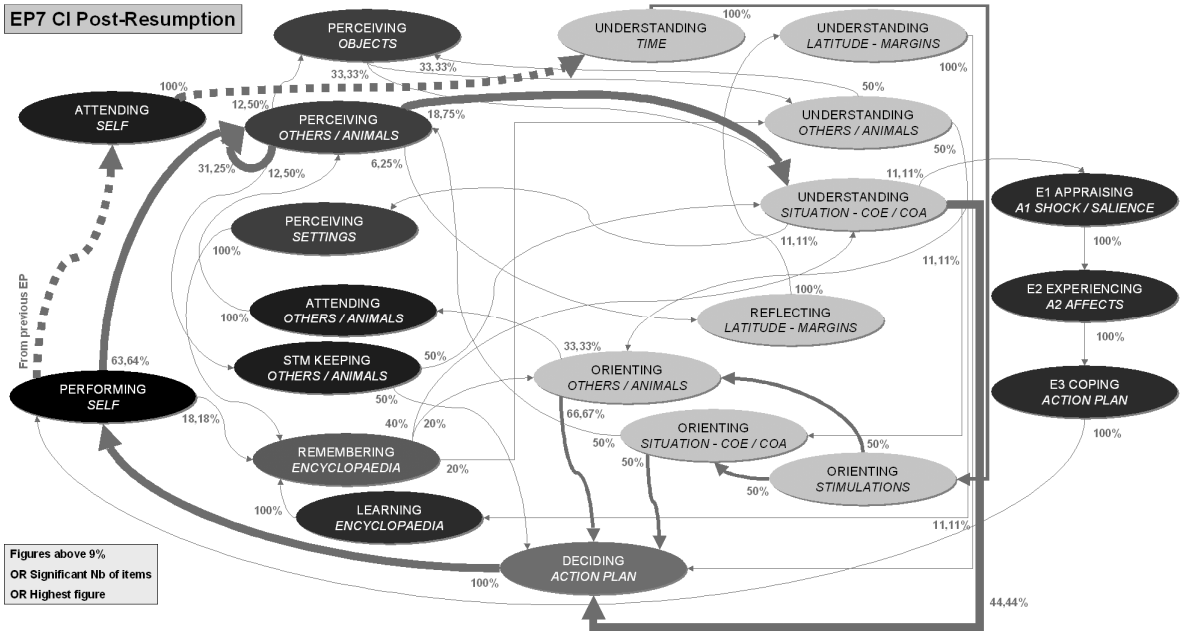


Figure 32 CogOp-based decision network of experience phase : 7 CI Post-Resumption

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
ATTENDING - OTHERS / ANIMALS	100,00%	PERCEIVING - OTHERS / ANIMALS
ATTENDING - SELF	100,00%	UNDERSTANDING - TIME
DECIDING - ACTION PLAN	100,00%	PERFORMING - SELF
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	100,00%	E3 COPING - ACTION PLAN
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
LEARNING - ENCYCLOPAEDIA	100,00%	REMEMBERING - ENCYCLOPAEDIA
ORIENTING - OTHERS / ANIMALS	66,67%	DECIDING - ACTION PLAN
ORIENTING - OTHERS / ANIMALS	33,33%	ATTENDING - OTHERS / ANIMALS
ORIENTING - SITUATION - COE / COA	50,00%	DECIDING - ACTION PLAN
ORIENTING - SITUATION - COE / COA	50,00%	PERCEIVING - OTHERS / ANIMALS
ORIENTING - STIMULATIONS	50,00%	ORIENTING - OTHERS / ANIMALS
ORIENTING - STIMULATIONS	50,00%	ORIENTING - SITUATION - COE / COA
PERCEIVING - OBJECTS	33,33%	STM KEEPING - OBJECTS
PERCEIVING - OBJECTS	33,33%	UNDERSTANDING - OTHERS / ANIMALS
PERCEIVING - OBJECTS	33,33%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	31,25%	PERCEIVING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	18,75%	UNDERSTANDING - SITUATION - COE / COA
PERCEIVING - OTHERS / ANIMALS	12,50%	PERCEIVING - OBJECTS
PERCEIVING - OTHERS / ANIMALS	12,50%	STM KEEPING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	6,25%	ATTENDING - OTHERS / ANIMALS
PERCEIVING - OTHERS / ANIMALS	6,25%	REFLECTING - LATITUDE - MARGINS
PERCEIVING - OTHERS / ANIMALS	6,25%	REMEMBERING - ENCYCLOPAEDIA
PERCEIVING - OTHERS / ANIMALS	6,25%	UNDERSTANDING - LATITUDE - MARGINS

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
PERCEIVING - SETTINGS	100,00%	REMEMBERING - ENCYCLOPAEDIA
PERFORMING - SELF	63,64%	PERCEIVING - OTHERS / ANIMALS
PERFORMING - SELF	18,18%	REMEMBERING - ENCYCLOPAEDIA
PERFORMING - SELF	9,09%	PERFORMING - SELF
PERFORMING - SELF	9,09%	STM KEEPING - SETTINGS
REFLECTING - LATITUDE - MARGINS	100,00%	UNDERSTANDING - LATITUDE - MARGINS
REMEMBERING - ENCYCLOPAEDIA	40,00%	UNDERSTANDING - SITUATION - COE / COA
REMEMBERING - ENCYCLOPAEDIA	20,00%	ORIENTING - OTHERS / ANIMALS
REMEMBERING - ENCYCLOPAEDIA	20,00%	ORIENTING - STIMULATIONS
REMEMBERING - ENCYCLOPAEDIA	20,00%	UNDERSTANDING - OTHERS / ANIMALS
STM KEEPING - OBJECTS	100,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - OTHERS / ANIMALS	50,00%	DECIDING - ACTION PLAN
STM KEEPING - OTHERS / ANIMALS	50,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - SETTINGS	100,00%	UNDERSTANDING - SITUATION - COE / COA
UNDERSTANDING - LATITUDE - MARGINS	100,00%	DECIDING - ACTION PLAN
UNDERSTANDING - OTHERS / ANIMALS	50,00%	ORIENTING - OTHERS / ANIMALS
UNDERSTANDING - OTHERS / ANIMALS	50,00%	PERCEIVING - OBJECTS
UNDERSTANDING - SITUATION - COE / COA	44,44%	DECIDING - ACTION PLAN
UNDERSTANDING - SITUATION - COE / COA	11,11%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - SITUATION - COE / COA	11,11%	LEARNING - ENCYCLOPAEDIA
UNDERSTANDING - SITUATION - COE / COA	11,11%	ORIENTING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	11,11%	PERCEIVING - OTHERS / ANIMALS
UNDERSTANDING - SITUATION - COE / COA	11,11%	PERCEIVING - SETTINGS
UNDERSTANDING - TIME	100,00%	ORIENTING - STIMULATIONS

13.6.11. Intermediate level : 8 CI Post-Debriefing phase

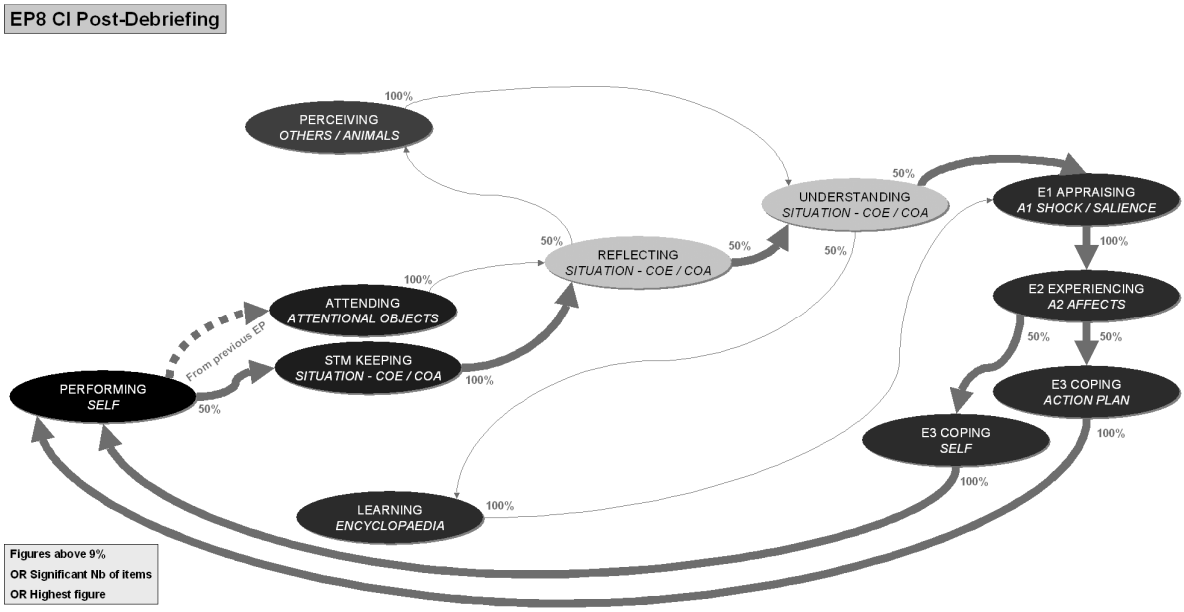


Figure 33 CogOp-based decision network of experience phase : 8 CI Post-Debriefing

Data :

GENOTYPIC COGOP	FREQ OF PHENOTYPIC COGOP →	FOLLOWED BY PHENOTYPIC COGOP
ATTENDING - ATTENTIONAL OBJECTS	100,00%	REFLECTING - SITUATION - COE / COA
E1 APPRAISING - A1 SHOCK / SALIENCE	100,00%	E2 EXPERIENCING - A2 AFFECTS
E2 EXPERIENCING - A2 AFFECTS	50,00%	E3 COPING - ACTION PLAN
E2 EXPERIENCING - A2 AFFECTS	50,00%	E3 COPING - SELF
E3 COPING - ACTION PLAN	100,00%	PERFORMING - SELF
E3 COPING - SELF	100,00%	PERFORMING - SELF
LEARNING - ENCYCLOPAEDIA	100,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
PERCEIVING - OTHERS / ANIMALS	100,00%	UNDERSTANDING - SITUATION - COE / COA
PERFORMING - SELF	50,00%	PERFORMING - SELF
PERFORMING - SELF	50,00%	STM KEEPING - SITUATION - COE / COA
REFLECTING - SITUATION - COE / COA	50,00%	PERCEIVING - OTHERS / ANIMALS
REFLECTING - SITUATION - COE / COA	50,00%	UNDERSTANDING - SITUATION - COE / COA
STM KEEPING - SITUATION - COE / COA	100,00%	REFLECTING - SITUATION - COE / COA
UNDERSTANDING - SITUATION - COE / COA	50,00%	E1 APPRAISING - A1 SHOCK / SALIENCE
UNDERSTANDING - SITUATION - COE / COA	50,00%	LEARNING - ENCYCLOPAEDIA

We can note that all but one intermediate level decision networks contain an affect coping sequence (E1 → E2 → E3 CogActs sequence shown on the right hand side of graphs).

13.6.12. Decision networks of the detailed (Present Moment) level

Decision networks presented above are of the intermediate level (CI Experience Phases). CogOp-based decision networks of the detailed level (of the 44 PMs) are presented in ANNEX 14. Whether at the intermediate or at the detailed level, the shape of decision networks varies:

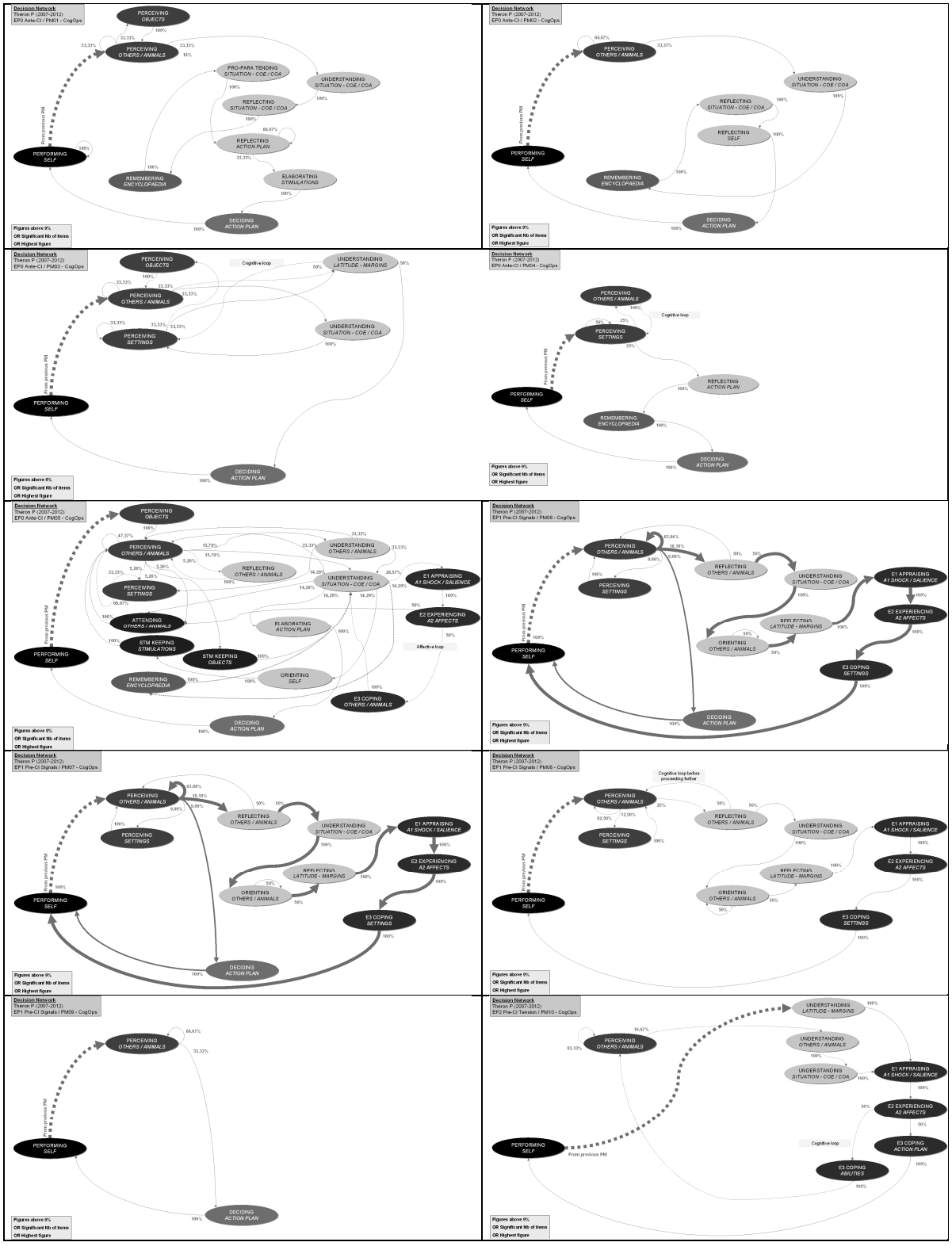


Figure 34 Visual evidence of the variation in shape of decision networks during the first ten PMs

Above, a glance at at the general pattern of the decision networks of the first ten PMs (for more visible and complete diagrams of PM-level decision networks refer to ANNEX 14) provides a clear view of this variation from one PM to the next (ordered from left to right, top to down).

13.7. Conclusion : precautions taken to assure the scientificity of the study, and limits

The following precautions were taken in order to assure the scientificity of the PCA study of Lieutenant A's case :

- Veridicality / authenticity of the Elicitation Interview and of the subject's recalls :
    - The insight of how BSPP Firemen act, and of their common cultural and regulatory background gained from the four months immersion in Montmartre helped us to understand Lieutenant A's narrative and to make assumptions about some of his non-narrated cognitive operations.
    - A review of the resequenced narrative (after the chronotext was finalised) was performed with Lieutenant A in November 2007.
    - A critical review of the authenticity of Lieutenant A's experience and evocation stance was performed on the basis of the signs given by the subject during the EI and of Vermersch's (2006) guidelines :
        - His first-person narration (he says "I" almost all the time, rarely "we" or "one").
        - Voice intonations : quasi-stammering, hesitations, variations of the speech pace and non verbal signs (stammering, hesitations, red patches appearing on his face, moments of silence in his narration, eyes in a position of rememoration or reflection). In the context of this particular EI, this indicates an absence of premeditated, well rehearsed social construction of the subject's discourse.
        - Spontaneous narrative initiatives (drawing the map of the intervention place, referring to it when he felt he had to clarify things, quotations of other people's utterances).

- The narration was mainly centred on facts, little on the subject's retrospective interpretation. The almost total absence of explications is very significant of his focus on facts.

- Validity (and ecological validity) :

  - Lieutenant A's case, the goals and methodological principles, and the work done on data processing and data analysis were presented to several researchers and to BSPP peers and discussed : Pierre Vermersch (CNRS) in 2009 (It covered the quality of the narrative and the data processing steps : semantic parsing, chronotext and re-sequencing, cognigraph) ; Thales Computing Science Research Department (ThereSIS) : March 9th, 2009 ; Mines ParisTech (Crises and Risk Research Centre) : June 6th, 2009 (A validation of the research object : the episode of cognitive experience and the Present Moment) ; Carnegie Mellon Portugal: January 20th, 2010 ; IMASSA (French Army's Medical and Psychological Studies Centre) in 2010. The findings of the analysis of Lieutenant A's case were submitted to the expert judgement of senior BSPP Firemen. The last presentation was made on June 16th, 2013.

One of the limits to the scientificity of our study was the impossibility to perform cross-coding with the help of other researchers. There were two reasons for this :

- The novelty of the approach : the PCA framework being novel, the researchers we approached after Lieutenant A's interview did not know it and at the time there were no sufficient guidelines to help them.

- Their lack of time.

Alternatively, several *rounds of encoding from anew* and of data processing were performed : October – December 2007, July & August 2008, July & August 2009, July & August 2010, July & August 2011, July & August 2012 (the current version), with a time lapse between rounds of several months, during which time no work at all was done with the material on hand.

This process was called *distantiation* by Klein & Hoffman (2008, p. 72). Each interval between rounds effectively led to forgetting anterior choices to some extent, to reconsider

the problem nearly from anew, and to refine the semantic analysis technique and the taxonomy of CogAct and CogObj. The successive improvements of the cognitive taxonomy gained through these rounds of work are presented in ANNEX 18. Progress was made in several areas :

- The chronological resequencing of speech clauses was verified and validated. It was validated by Lieutenant A in November 2007.

- We better and better took into account the subject's self-centric cognitive perspective in the semantic analysis of his narrative. Actions performed by others are seen as food for the subject's cognition, for his perception, whereas he can narrate his own actions as his. His emotions, thoughts, etc. are his too. Therefore, cognitive acts and objects had to be defined from the subject's standpoint and objects could relate to either himself or to external others or objects. CogActs and CogObjs had to match the first-person perspective: the subject perceives such object, for instance in himself or in another person, hence the distinction between objects[293] : self, others and animals, objects, settings.

- We sought to establish a neat distinction between cognitive acts and objects, and to clearly differentiate definitions between acts, and between objects.

- We included cognitions and actions under a single term (CogOps) to facilitate the reading of the study's report.

- We codified the sub-types (CogActST and CogObjST) taxonomy : each one starts with a 5 position code followed by an expanded denomination precising its definition, like in this CogObj sub-type : "*AFF31- Affect: Fright / Stupor (Brief and irrepressible sentiment of imminent self-destruction and powerlessness, beyond fear)*".

- The encoding of decision-making steps (DM Steps) was performed twice, in July-August 2011 and July-August 2012. Only minor changes intervened from one round to the next..

- The determination and encoding of the attributes of Present Moments and CogOps (to create the PM data set and CogOp data set in the data analysis phase) were performed

in July & August 2011 and checked in July & August 2012. Minor changes occurred from one round to the next.

Part 4. ANALYSIS, DISCUSSION AND CONCLUSIONS

CHAPTER 14. Seven findings about DMA and PTR

Maurel (2008) says that once the cognitive experience of an individual in a given situation has been narrated through an Elicitation Interview (EI) the question becomes "*what to do with this material ?*" (p. 7). The richness of the data provided by Lieutenant A's narrative helps to understand how a Critical Incident (CI) affects an individual and how the subject responds to situations and displays peritraumatic resilience (PTR). This chapter presents seven findings in relation to Decision-Making-in-Action (DMA) and to PTR. The present study is an "*idiography*" (Shaughnessy et al., 2006, p. 43) hence the interpretative character of some of the following analyses. The efforts made to guarantee the scientificity of the data collection and data processing activities have been described in previous chapters.

Three data sets were created : the CogOp, PM and EP data sets[294]. Their attributes, origins and analyses are presented in ANNEX 15. Attributes were discretised as their numerical (categorical or ordinal) definition showed non normal distributions. Exploratory factor analyses and bayesian analyses were performed in order to reveal the rules of production of Lieutenant A's cognitive trajectories and resilience mechanisms.

14.1. The pattern of Decision-Making-in-Action (DMA)

The analysis of Lieutenant A's DMA patterns yields four findings :

- Finding 1 : There are four DMA patterns in which affects play an important part
- Finding 2 : DMA patterns change from one PM to the next
- Finding 3 : The shape of cognitive trajectories varies within each DMA pattern
- Finding 4 : Recognition, memory and metacognition play an unclear part in DMA.

14.1.1. Finding 1 : There are four DMA patterns in which affects play an important part

Given the nature of Critical Incidents that expose subjects to trauma, a dominance of affect in Lieutenant A's cognitive activity appeared as a fair hypothesis. De facto, decision networks highlight the role played by affects in Lieutenant A's DMA cognitive process.

The global decision network shows a dominant (boldest arrows = most frequent phenotypic links) *affect-based* cognitive trajectory (i.e. where emotion is determinant in sparking ACTION = "PERFORMING – *SELF*" CogOp), an alternative (less frequent, second boldest links) *deliberation-based* cognitive pattern (where reasoning is determinant), and a number of much less frequent phenotypic links (thinnest arrows) :

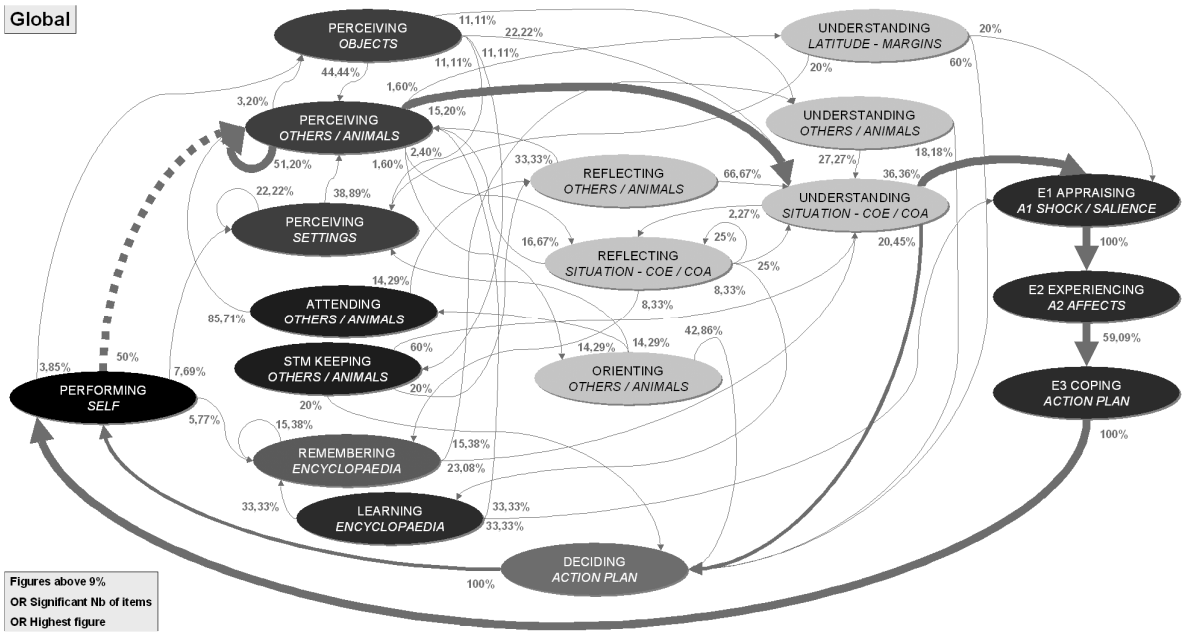


Figure 35 Lieutenant A's CogOp-based global decision network

At this *global* level of the whole episode, the affect-based DMA pattern seems the most influential over Lieutenant A's behaviour and this is confirmed at the *intermediate* level of CI Experience Phases as their decision networks indicate that two thirds of the nine phases have affect-based driving cognitive trajectories :

CI Experience Phase	Driving / Alternative[295] Cognitive Trajectory
0 Ante-CI	Deliberation-based / no alternative
1 Pre-CI Signals	**Affect-based** / Deliberation-based trajectory
2 Pre-CI Tension	**Affect-based** / no alternative
3 CI Trauma Exposure	**Affect-based** / no alternative
4 CI Post-Tension	**Affect-based** / Deliberation-based trajectory
5 CI Post-Relief	Deliberation-based / no alternative
6 CI Post-Venting	**Affect-based** / Deliberation-based trajectory
7 CI Post-Resumption	Deliberation-based / affect-based trajectory
8 CI Post-Debriefing	**Affect-based** / no alternative

Table 36 Driving and alternative cognitive trajectories in the 9 phases of the experience of a Critical Incident

In total, four DMA patterns can be identified.

But, in contrast to what precedes, if we look at the decision networks of the Present Moment level (based on the PM data set ; also see PM decision networks in ANNEX 14) we notice the predominance of deliberation-based DMA patterns :

1) DB_NA = a Deliberation-based driving cognitive trajectory WITH No alternative (26 occurrences out of 44 PMs[296], i.e. 59,1% of all PMs)

2) AB_NA = an Affect-based driving cognitive trajectory WITH No alternative (14 occurrences, 31,8% of all PMs)

3) DB_AL = a Deliberation-based driving cognitive trajectory INCLUDING an Affective loop WITH No alternative (2 occurrences, 4,55% of all PMs)

4) AB_DL = an Affect-based driving cognitive trajectory INCLUDING a decision loop WITH No alternative (2 occurrences, 4,55% of all PMs).

If we group DMA patterns 1 and 3 above, a total of 63,65%, about two thirds, of all PMs rely upon a deliberation-based driving cognitive trajectory, in an exact opposition to the picture previously drawn from the intermediate and global levels of analysis. The detailed view (PM level) invalidates the intermediate and global views, as well as the *a priori* hypothesis that affect might play a predominant part in the experience of a CI.

If affect-based cognitive trajectories play an important part in DMA, Lieutenant A's data suggest that deliberation-based cognitive trajectories are more influent.

14.1.2. Finding 2 : DMA patterns change from one PM to the next

The second finding is the Inter-Variability of DMA patterns as the experience moves on.

Inter-Variability refers to the change of DMA pattern from one segment of experience to the next within a given level of analysis (intermediate – CI experience phases –, or detailed – PM –).

14.1.2.1. Evidence of Inter-Variability

The PM data set shows that the DMA pattern of the 44 PMs changes from one PM to the next :

CI Experience Phase	Present Moment	P_A_CogTrajectories
0	01 - Waiting to see…	DB_NA
	02 - Deciding to intervene	DB_NA
	03 - Deciding to park in the garden	DB_NA
	04 - Deciding to attend to the victims	DB_NA
	05 - Attending to the victims and leaving	*DB_AL*
	06 - Deciding to close the front gate on the way back to dogs	DB_NA
	07 - Deciding to send an ambience message to BSPP	DB_NA
1	08 - Distracting from anxiety	**AB_NA**
	09 - A glimpse of the victims	DB_NA
2	10 - The father irrupts…	**AB_NA**
3	11 - The dogs attack !!! Shoot them ! Shoot ! Shoot !	***AB_DL***
	12 - The fright	***AB_DL***
4	13 - Searching the missing dog	DB_NA
	14 - Continuing the search and being astonished by the dogs unit	**AB_NA**
	15 - Following the dogs unit into the adjacent parcel	DB_NA
	16 - Searching the adjacent parcel : worrying !	**AB_NA**
	17 - Going back into the garden	DB_NA
	18 - Searching the cellar	**AB_NA**
	19 - No luck with the cellar : restarting the search	DB_NA
5	20 - The dog has been found !	DB_NA
	21 - Seeing the dogs dying	DB_NA
6	22 - First realisation of what went on	**AB_NA**
	23 - A quick chat with a colleague…	DB_NA
	24 - Asking questions about the shooting	**AB_NA**
	25 - Further questions about the shooting	DB_NA
	26 - First answers…	**AB_NA**
	27 - 15 Bullets ?…	**AB_NA**
	28 - Even more	*DB_AL*
	29 - 45 bullets !	**AB_NA**
	30 - Why do they carry envelops ?	DB_NA
	31 - They need to collect the bullets	DB_NA
	32 - Good luck with the bullets then !	**AB_NA**
7	33 - Deciding to go back inside	DB_NA
	34 - What happened ?, she asks	DB_NA
	35 - It sounded like heavy gun fire, colleagues say	DB_NA
	36 - Could neighbours have been shot too ?…	DB_NA
	37 - Deciding to ask where victims are to be dispatched	DB_NA
	38 - Asking about the daughter	DB_NA
	39 - You can't walk that woman in her condition !	**AB_NA**
	40 - The crowd are watching : bring the PSR inside !	DB_NA
	41 - The mother departs : time to report and go	DB_NA
	42 - Back in the car, sending radio message	DB_NA
8	43 - Starting to think and talk about the events	**AB_NA**
	44 - Reflecting upon the course of things	**AB_NA**

Table 37 Distribution of the 4 DMA patterns among the 44 Present Moments (PM data set

14.1.2.2. Exploratory Factor Analysis of Inter-Variability

The study of Inter-Variability was based upon the PM data set (ANNEX 15). It aimed at finding the attributes (ANNEX 15) that best predict a PM's DMA pattern. ANNEX 15 shows non normal distributions and attributes were discretised. Correlation coefficients point to dependencies between attributes : the Chi-square test shows all but one p-values

around 0[297]. Dependencies were confirmed by the Cramér's *v* coefficient[298], compatible with both nominal and ordinal attributes, but as it is symmetric (not Y→X directional) it could not help to determine an Y→X network of dependencies. A bayesian network was generated from the PM data set[299] and the EMOTION attribute (the *stressfulness* of the PM context) appeared to be a construct of other attributes :

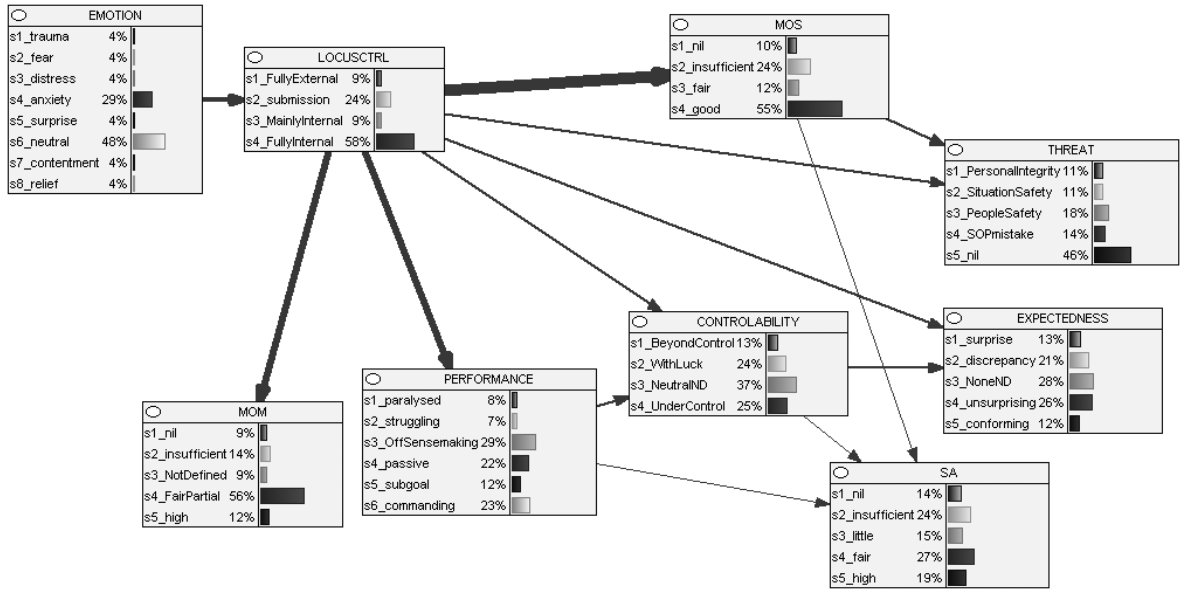


Figure 36 Stressfulness co-occurrence wit other PM attributes (Bayesian network ; width of arrows shows strength of influence)

None of these attempts, however, helped to establish a dependency of the variable to predict (DMAPATTERN) upon other attributes. Using Quinlan's (1993) C4.5 Decision Tree and Breiman's (2001) Random Forest classification algorithms[300], seven analyses were performed, each one seeking an optimal combination of factors minimising the prediction's error rate. The variable to predict is DMAPATTERN :

Attributes	Variable	Factors Trial 1	Factors Trial 2	Factors Trial 3	Factors Trial 4	Factors Trial 5	Factors Trial 6	Factors Trial 7
DMAPATTERN	Yes							
EMOTION		Yes	Yes			Yes	Yes	Yes
SA			Yes			Yes	Yes	
MOM			Yes	Yes	Yes	Yes		
MOS			Yes	Yes	Yes	Yes		
LOCUSCTRL			Yes				Yes	
THREAT			Yes	Yes				Yes
PERFORMANCE			Yes	Yes	Yes			
EXPECTEDNESS			Yes	Yes		Yes	Yes	
CONTROLABILITY			Yes			Yes		
C4.5 error rate :		11,36	22,73	20,45	31,82	6,82	9,09	4,55
Random Forest error rate :		11,36	18,18	22,73	25,00	11,36	11,36	4,55

Table 38 C4.5 and Random Forest error rates in the successive analyses of DMA patterns factors

The last attempt using Breiman's Random Forest, yielded the same lowest error rate of 4,55% of DMA patterns *not predicted* than Quinlan's C4.5, and its tree[301] (below) was more detailed :

• EMOTION in [s6_neutral]) AND	
	• THREAT in [s4_SOPmistake] then DMAPATTERN = **DB_NA** (100,00 % of 3 examples) [302]
	• THREAT in [s5_nil] then DMAPATTERN = **DB_NA** (93,33 % of 15 examples)
	• THREAT in [s3_PeopleSafety] then DMAPATTERN = **DB_NA** (100,00 % of 6 examples)
	• THREAT in [s2_SituationSafety] then DMAPATTERN = **DB_NA** (0,00 % of 0 examples)
	• THREAT in [s1_PersonalIntegrity] then DMAPATTERN = **DB_NA** (0,00 % of 0 examples
• EMOTION in [s4_anxiety]) AND	
	• THREAT in [s4_SOPmistake] then DMAPATTERN = **DB_AL** (100,00 % of 1 examples)
	• THREAT in [s5_nil] then DMAPATTERN = **AB_NA** (87,50 % of 8 examples)
	• THREAT in [s3_PeopleSafety] then DMAPATTERN = **AB_NA** (100,00 % of 3 examples)
	• THREAT in [s2_SituationSafety] then DMAPATTERN = **DB_NA** (100,00 % of 2 examples)
	• THREAT in [s1_PersonalIntegrity] then DMAPATTERN = **DB_NA** (0,00 % of 0 examples
• EMOTION in [s3_distress] then DMAPATTERN = **AB_NA** (100,00 % of 1 examples)	
• EMOTION in [s2_fear] then DMAPATTERN = **AB_DL** (100,00 % of 1 examples)	
• EMOTION in [s1_trauma] then DMAPATTERN = **AB_DL** (100,00 % of 1 examples)	
• EMOTION in [s7_contentment] then DMAPATTERN = **DB_NA** (100,00 % of 1 examples)	
• EMOTION in [s8_relief] then DMAPATTERN = **DB_NA** (100,00 % of 1 examples)	
• EMOTION in [s5_surprise] then DMAPATTERN = **AB_NA** (100,00 % of 1 examples).	

Table 39 DMA pattern Inter-Variability decision tree [Breiman's (2001) Random Forest, error rate = 4,55%]

Based on these results, the following diagram shows the rules of activation of DMA patterns[303] in Lieutenant A's case :

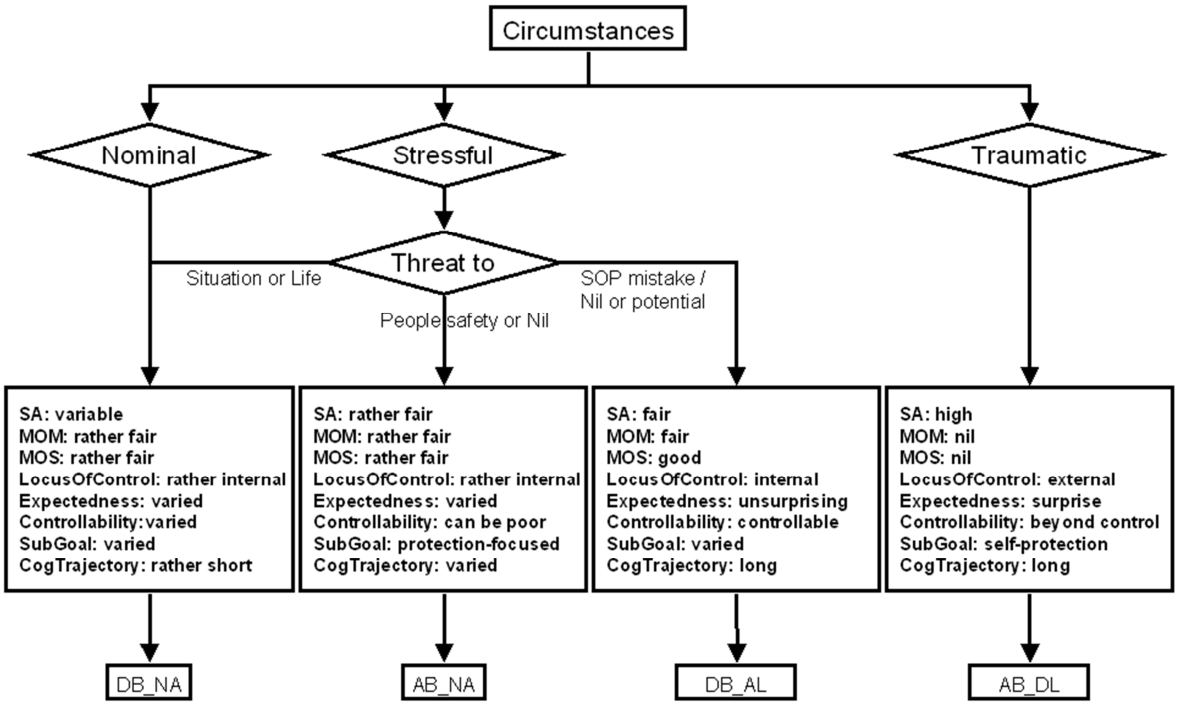


Figure 37 Rules of activation of the four DMA patterns (error rate = 4,55%)

14.1.3. Finding 3 : The shape of cognitive trajectories varies within each DMA pattern

14.1.3.1. Evidence of Intra-Variability

Decision Networks (Chapter 13) are statistical abstractions of cognitive processes based on phenotypic links' frequencies. They show the existence in any of the four DMA Patterns of a *driving* cognitive trajectory (the most frequent one), possibly of an *alternative* cognitive trajectory (less frequently), and possibly also of infrequent phenotypic links between CogOps. There are also what looks like cognitive *loops* in the middle in some cases. Decision networks also show that the shape of the cognitive trajectory within a given DMA pattern varies. In any generic DMA pattern, the shape of the Lieutenant A's cognitive trajectory varies in many ways along the 44 Present Moments of the studied episode.

Intra-Variability refers to the multiple detailed shapes of cognitive trajectories that can be found within each DMA Pattern, and, beyond, throughout all Present Moments.

The following table shows that the steps[304] of the cognitive trajectories (phenotypic chain of cognitive operations) of the 44 Present Moments involve different families[305] of CogAct (parentheses indicate co-occuring families of CogActs) :

Present Moment	DMA pattern	Decomposition of the cognitive trajectory into steps and characterisation of the shape of the DMA pattern							
		S1	S2	S3	S4	S5	S6	S7	S8
01 - Waiting to see…	DB_NA	Perceiving	Interpretation (LTM)	Planning	Decision				
02 - Deciding to intervene	DB_NA	Perceiving	Interpretation (LTM)	Planning	Decision				
03 - Deciding to park in the garden	DB_NA	Perceiving	Interpretation	Decision					
04 - Deciding to attend to the victims	DB_NA	Perceiving	Interpretation	Decision					
05 - Attending to the victims and leaving	DB_AL	Perceiving	Interpretation	Affect Coping	Attention & STM	Affect Coping	Interpretation	Planning	Decision
06 - Deciding to close the front gate on the way back to dogs	DB_NA	Perceiving	Interpretation	Planning	Decision				
07 - Deciding to send an ambience message to BSPP	DB_NA	LTM	Decision						
08 - Distracting from anxiety	AB_NA	Perceiving	Interpretation	Affect Coping					
09 - A glimpse of the victims	DB_NA	Attention & STM	Decision						

Present Moment	DMA pattern	Decomposition of the cognitive trajectory into steps and characterisation of the shape of the DMA pattern							
		S1	S2	S3	S4	S5	S6	S7	S8
10 - The father irrupts…	AB_NA	Interpretation	Affect Coping	Perceiving	Interpretation	Affect Coping			
11 - The dogs attack !!! Shoot them ! Shoot ! Shoot !	AB_DL	Perceiving	Interpretation	Coping					
12 - The fright	AB_DL	Perceiving	Interpretation	Coping	Interpretation	Perceiving	Interpretation	Coping	
13 - Searching the missing dog	DB_NA	Planning	Interpretation	Decision					
14 - Continuing the search and being astonished by the dogs unit	AB_NA	Attention & STM	Perceiving	Interpretation	Coping				
15 - Following the dogs unit into the adjacent parcel	DB_NA	Metacognition	Decision						
16 - Searching the adjacent parcel : worrying !	AB_NA	Perceiving	Interpretation	Coping					
17 - Going back into the garden	DB_NA	Perceiving	Interpretation	Decision					
18 - Searching the cellar	AB_NA	Perceiving	Interpretation	Coping					
19 - No luck with the cellar : restarting the search	DB_NA	Decision							
20 - The dog has been found !	DB_NA	Perceiving	Interpretation	Decision					
21 - Seeing the dogs dying	DB_NA	Perceiving	Interpretation	Perceiving	Planning	Decision			
22 - First realisation of what went on	AB_NA	Attention & STM	Interpretation	Coping					
23 - A quick chat with a colleague…	DB_NA	Interpretation	Decision						
24 - Asking questions about the shooting	AB_NA	Interpretation	Coping						
25 - Further questions about the shooting	DB_NA	Planning	Decision						
26 - First answers…	AB_NA	Interpretation	Planning	Coping					
27 - 15 Bullets ?…	AB_NA	Perceiving	Attention & STM	Interpretation	Coping				
28 - Even more	DB_AL	Perceiving	Interpretation	Coping	Perceiving	Interpretation	Decision		
29 - 45 bullets !	AB_NA	Perceiving	Interpretation	Attention & STM	Coping				
30 - Why do they carry envelops ?	DB_NA	Perceiving	Interpretation	Planning	Decision				
31 - They need to collect the bullets	DB_NA	Interpretation (LTM)	Decision						

Present Moment	DMA pattern	Decomposition of the cognitive trajectory into steps and characterisation of the shape of the DMA pattern							
		S1	S2	S3	S4	S5	S6	S7	S8
32 - Good luck with the bullets then !	AB_NA	Perceiving	Interpretation	Coping					
33 - Deciding to go back inside	DB_NA	Attention & STM	Interpretation	Planning	Decision				
34 - What happened ?, she asks	DB_NA	Perceiving	Attention & STM	Interpretation	Decision				
35 - It sounded like heavy gun fire, colleagues say	DB_NA	Perceiving	Attention & STM	Decision					
36 - Could neighbours have been shot too ?…	DB_NA	Attention & STM	Interpretation	Metacognition	LTM	Planning	Attention & STM	Interpretation	Decision
37 - Deciding to ask where victims are to be dispatched	DB_NA	LTM	Planning	Decision					
38 - Asking about the daughter	DB_NA	Perceiving	Interpretation	Perceiving	Interpretation	Planning	Decision		
39 - You can't walk that woman in her condition !	AB_NA	Perceiving	Attention & STM	Interpretation	Coping				
40 - The crowd are watching : bring the PSR inside !	DB_NA	Perceiving	Interpretation	Decision					
41 - The mother departs : time to report and go	DB_NA	Perceiving	Perceiving	Interpretation	Perceiving	LTM	Planning	Decision	
42 - Back in the car, sending radio message	DB_NA	NA							
43 - Starting to think and) talk about the events	AB_NA	Attention & STM	Interpretation	Coping					
44 - Reflecting upon the course of things	AB_NA	Attention & STM	Interpretation	Metacognition	Coping				

Table 40 The variety of internal shapes of DMA patterns

Like Inter-Variability, Intra-Variability is consistent with the finding of a plurality of decision-making strategies raised by Klein (1997, 1998), Lipshitz (1997a), Orasanu & Fischer's (1997), Crego & Spinks (1997), Hutton & Klein (1999) and Flin et al. (2007). Refer to chapter 4.4.

14.1.3.2. Exploratory Factor Analysis of Intra-Variability

The analysis of the factors of Intra-Variability aimed at unveiling the attributes and rules that in Lieutenant A's case contribute to the election of phenotypic decision-making steps (pheno DM Step). It was based upon the CogOp data set (ANNEX 15).

The analysed variable (the one to predict) is **Pheno_DM** (the phenotypic – current – DM Step following a genotypic – anterior – DM Step). Rather than defining the categories of Pheno_DM as the values of CogOp (i.e. all possible pairs of {CogAct ; CogObj}) as this was giving birth to too many values, which ultimately prevents finding correlations between the attributes and the variable) we reduced the number of values of Pheno_DM to predict by substituting to CogOps their equivalent DM Step (ANNEX 12) as presented in the taxonomy.

Attributes considered for this analysis were :

- The previous DM Step : Geno_DM.

- Descriptive attributes : Ctrl, Agency, Valence, Attention, Temp and FOCUS, both in their *phenotypic* (that of the DM Step to predict) and *genotypic* (i.e. of the previous DM Step) values.

- Attributes refering to the contextual Present Moment (PM) described by the Pheno_EMOTION attribute, i.e. the stressfulness of the context in which a CogOp is performed. The value of a PM's attribute is attributed to all CogOps / DM Steps it includes. *EMOTION* was found to be a construct of other PM attributes (see finding 2 above).

- The feeling left on the subject's consciousness by the whole episode of experience, as defined by Moshkina (2006) and Moshkina & Arkin (2003, 2005) as "*feelings about an object, a person or a issue*", as "*affective attitudes*" represented in the TAME's affective module[306] as a function of the total number of encounters, up to date, with the features of that object. This notion is materialised by the Pheno_Mean_EMOTION attribute, defined here as the progressive mean of the EMOTION attribute calculated for each DM Step i.e. the mean of the values of EMOTION assigned to all preceeding DM Step up to and including the DM Step to predict. The chart shows Pheno_Mean_EMOTION along the 460 DM Steps :

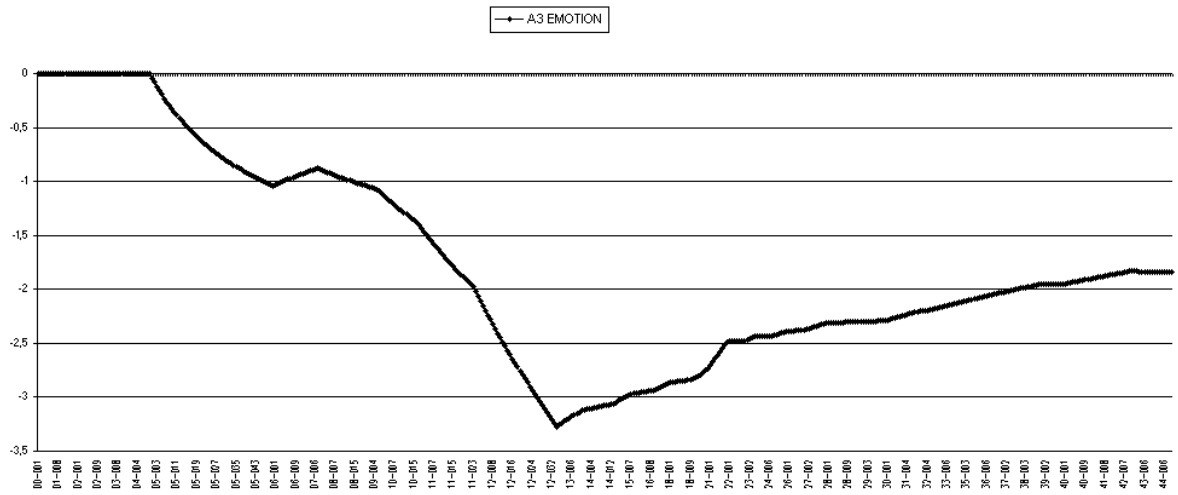


Figure 38 The progressive value of the Mean_EMOTION attribute along the 460 CogOps

Pheno_Mean_EMOTION was discretised on the following grounds as the progressive mean of the EMOTION attribute is an abstract notion:

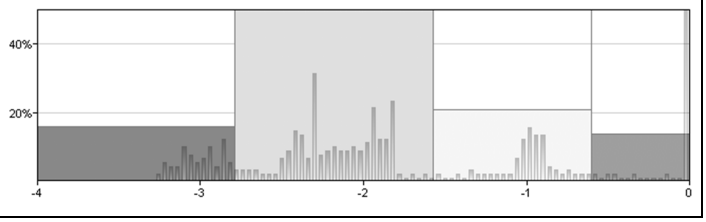
Mean_EMOTION	Numerical range		n	Distribution
Discrete values	from	to		
s1_SignificantNegative		-2.779237	73	
s2_MildNegative	-2.779237	-1.56382	227	
s3_FairNegative	-1.56382	-0.595338	95	
s4_LittleNegative	-0.595338		63	

Table 41 Attribute characterising the subject's general feeling of his experience while performing a CogOp

The values of Pheno_Mean_EMOTION are to be compared with those of EMOTION :

PM attributes	Definitions (plus numerical values and their meanings when assigned
EMOTION (stressfulness	The stressfulness of circumstances at hand : -10 (trauma), -6 (fear), -4 (distress), -2 (anxiety, disgust, reproach, distress), -1 (surprise), 0 (emotionlessness), 2 (contentment), 6 (relief) NB : Negative values correspond to negative emotions, and vice-versa.

The analysis of Inter-Variability of the DMA Pattern was performed as follows:

- The *CogOp data set* was defined as n = 459 CogOps / DM Steps, all attributes are discrete.

- Phenotypic attributes refer to attributes describing the CogOp / DM Step we seek to predict. Genotypic attributes refer to attributes describing the previous CogOp / DM Step in the whole sequence of Lieutenant A's cognitive operations.

- We first performed an Exploratory Factor Analysis to analyse dependencies between attributes. Based on Goodman-Kruskal's (1954) asymmetric λ[307], *Pheno_Ctrl* (a CogOp attribute, the subject's coping mode to regain / keep his level of agency at a CogOp) appeared as a construct of other genotypic CogOp attributes :

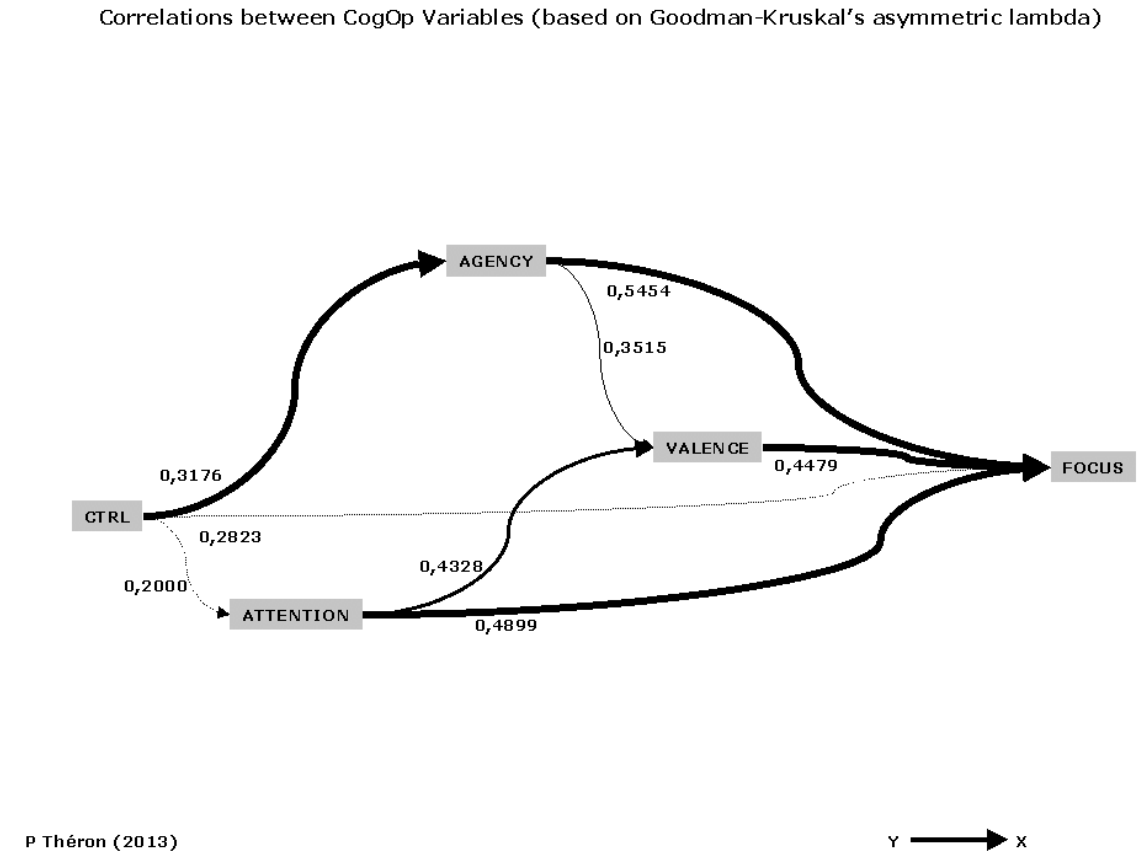


Figure 39 Pheno_Ctrl association with other CogOp attributes [Goodman-Kruskal's (1954) assymetric λ]

- The Chi-Square test (ANNEX 15) confirmed dependencies between attributes evidenced by the Goodman Kruskal's (1954) λ test. A bayesian analysis (using the Geno_FOCUSLEVEL attribute, an abstraction of the Geno_FOCUS attribute, presenting fewer categories than the latter) confirmed the likeliness of this construct :

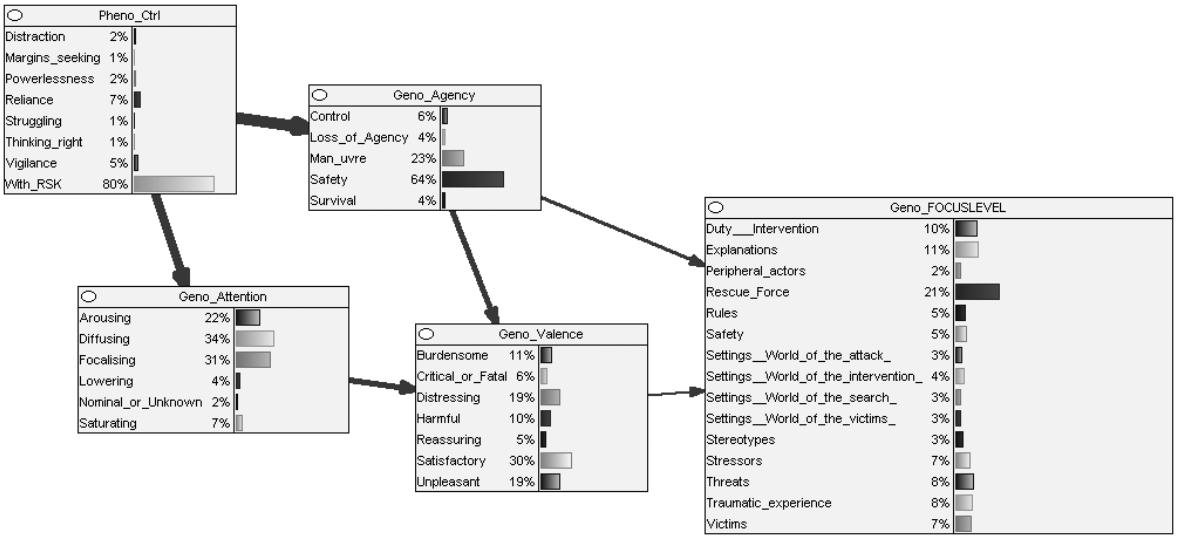


Figure 40 Pheno_Ctrl joint probabilities of occurence with other CogOp attributes (bayesian network

- But again, none of these tests allowed to find explicative factors of the target variable, Pheno_DM.

- Therefore, we resorted again on Quinlan's (1993) C4.5 Decision Tree algorithm and Breiman's (2001) Random Forest decision tree analysis algorithms to search the factors and rules active in the election of phenotypic DM Steps. Twelve trials were performed with C4.5 and Random Forest algorithms to look for the optimal factors and rules of election the Phenotypic DM Step across the entire episode of experience :

Attributes	**Variable**	**Factors**											
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Trial 11	**Trial 12**
Pheno_DM	Yes												
Pheno_EMOTION		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pheno_SA													
Pheno_MOM													
Pheno_MOS													
Pheno_LOCUSCTRL													
Pheno_THREAT								Yes					
Pheno_PERFORMANCE													
Pheno_EXPECTEDNESS													
Pheno_CONTROLABILITY													
Pheno_SUBGOAL				Yes							Yes	Yes	Yes
Pheno_Mean_EMOTION						Yes				Yes	Yes		Yes
Pheno_Sum_EMOTION							Yes	Yes	Yes			Yes	
Geno_DM		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geno_Ctrl			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geno_Agency													
Pheno_Agency													Yes
Geno_FOCUS					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pheno_FOCUS					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geno_Valence													
Pheno_Valence									Yes	Yes	Yes	Yes	Yes
Geno_Attention													
Pheno_Attention													Yes
Geno_Temp													
Pheno_Temp													Yes
C4.5 error rate :		38,13	35,08	32,46	10,68	10,24	10,24	8,06	8,28	8,5	7,84	7,63	**5,23**
Random Forest error rate :		36,82	36,17	30,28	13,94	13,29	11,76	13,29	10,89	10,89	7,84	8,06	11,76

Table 42 Successive trials of decision tree analysis of phenotypic DM Steps election

Trial twelve's C4.5 results being the most accurate (error rate = 5,23%) and in the form of production rules linking genotypic DM Steps with phenotypic DM Steps ("*if Geno_DM and Condition X Then Pheno_DM*"), while Random Forest results were less accurate, the C4.5 results of trial 12 were selected for analysis. The decision tree generated by the C4.5 algorithm was cleaned-up of nil phenotypic clauses ("*then Pheno_DM = y in 0,00% of 0 examples*") and of [Geno_DM → Pheno_DM] links = [DM60-Action → DM60-Action] sequences of actions that correspond only to holes in the narrated episode.

The analysis of the C4.5 production rules[308] shows that the stressfulness of CogOps' context (PM's *EMOTION* attribute) appears as the main factor in the election of DM Steps : DM01-Acquisition, DM21-Analysis, DM27-Judgement, DM31-Appraisal.

Other Phenotypic DM Steps are elected under a wide variety of factors and no clear production rule could be found.

14.1.4. Finding 4 : Recognition, memory and metacognition play an unclear part in DMA

The role played by memory and metacognition in DMA is hard to characterise. In a similar way, the reality of recognition-priming, described by Klein (1998) for instance, can only be inferred.

ANNEX 15 indicates the number of occurrences of CogAct and CogObj types and sub-types per CI Experience Phase in Lieutenant A's episode of experience. Numbers here are rather statistically insignificant :

- Attending and STM Keeping : Short Term Memory related CogOps (*STM KEEPING*) are performed on 12 occasions, of which 5 are assumed. They are activated mainly in experience phases posterior to trauma exposure when Lieutenant A tries to make sense of the events. Beside, *ATTENDING* CogOps are performed on 10 occasions, of which 6 were assumed.

- Long Term Memory (the subject's encyclopaedia) : Out of a total of 14 *REMEMBERING* CogActs performed, 8 being assumed, 12 were associated with

RUL12- Moral Rule and *RUL13- Procedure / Regulation - Practical method* CogObj sub-types.

- Prior recognition of the situation : Only 4 occurrences of a "pattern recognition" CogOp could be elicited [⇔*UND12- Recognising / Making an analogy with (a known pattern)* CogAct sub-type]. The shortness of many trajectories may point to the fact that situation recognition occurs on a regular basis but CogOps we found do not provide evidence of this.

- Learning from experience (metacognition) : On 4 occasions we could elicit or assume a "*LRN21- Noting / Memorising (a lesson = attitude, chunk of semantic Knowledge,)... "* CogOp sub-type. Beyond considering *learning from experience* as metacognition, the narrative does not reveal metacognitive processes.

14.2. The experience of Critical Incidents (CI) and Peritraumatic Resilience (PTR)

Three more findings can be drawn from the analysis of Lieutenant A's case :

- Finding 5 : CI Experience Phases are resilience-focused turns in the story plot

- Finding 6 : A Critical Incident is an experience of collapse of self-agency

- Finding 7 : PTR stems from a cognitive struggle for agency and from external support.

14.2.1. Finding 5 : CI Experience Phases are resilience-focused turns in the story plot

As seen earlier, Lieutenant A's experience of the CI (Critical Incident) has proceeded through nine documented phases. Each CI experience phase (EP) can be interpreted as corresponding to a *turn in the story plot*. We looked for what was changing from one EP to the next. The narrative shows that the subject had some awareness of the degradation of the situation before Phase #3, and that the focus of the subject's awareness of the situation started to change, in relation both to the pattern of events and to his own psychological comfort :

CI Experience Phase	Awareness of situation's status
0 Ante-CI	Duty Awareness
1 Pre-CI Signals	MOS+MOM [309] limitation (risk) Awareness

2 Pre-CI Tension	MOS+MOM collapse awareness
3 CI Trauma Exposure	Agency collapse awareness
4 CI Post-Tension	Situational discrepancies awareness
5 CI Post-Relief	Situation normalisation awareness
6 CI Post-Venting	Homeostasis need awareness
7 CI Post-Resumption	Duty Awareness
8 CI Post-Debriefing	Homeostasis need awareness

Table 43 Focus of situation awareness at each CI Experience Phase (interpreted from data

EP #4 shows that the subject "manages" his reconnection with duty when his attention is attracted by someone shouting "a dog is missing". In EP #6 a process of emotion self-diffusing and understanding helps him to recover enough calm to resume activity in EP #7. However, as Phase #8 shows also, the process of self-diffusing in the field did not suffice and the subject needed to do more talking with colleagues on the way back to the fire station. The following table presents three further attributes of CI Experience Phases that our analysis of the EP data set found to characterise these turns in the story plot : the subject's action ***sub-goal***, his ***coping focus***, i.e. what his coping efforts seek to regulate, a notion consistent with Higgins' (1997, 1998) prevention-focused[310] self-regulation[311] and with Carver et al.'s (1989) ways of coping, and the general ***resilience mechanism***, i.e. the kind of action he resorts on to handle adversity (NB : "NA" means "none") :

Experience Phase	Awareness of situation's status	Sub-goal	Coping focus	Resilience mechanism
0 Ante-Action	Duty Awareness	00- None/Be ready for action	NA	NA
0 Ante-CI	Duty Awareness	01- Save/Optimise efforts/resources/time	NA	NA
		02- Fulfil duty/Complete the job at hand	NA	NA
		03- Protect others / Secure	NA	NA
1 Pre-CI Signals	MOS+MOM limitation (risk) Awareness	03- Protect others / Secure	emotion_focused	distraction
		07- Distract oneself	emotion_focused	distraction
2 Pre-CI Tension	MOS+MOM collapse awareness	05- Avoid a problem	problem_focused	mitigation
3 CI Trauma Exposure	Agency collapse awareness	04- Protect oneself	self_preservation_focused	self_protection
4 CI Post-Tension	Situational discrepancies awareness	03- Protect others / Secure	emotion_focused	exogenous_opportunism
5 CI Post-Relief	Situation normalisation awareness	03- Protect others / Secure	emotion_focused	exogenous_opportunism
6 CI Post-Venting	Homeostasis need awareness	06- Get relief / De-stress / Vent emotions	emotion_focused	sensemaking
		08- Understanding / Interpreting	emotion_focused	sensemaking
		09- Support / Help	emotion_focused	sensemaking
7 CI Post-Resumption	Duty Awareness	02- Fulfil duty/Complete the job at hand	duty_focused	decision
		02- Fulfil duty/Complete the job at hand	NA	NA
		03- Protect others / Secure	NA	NA
		10- Be sociable	emotion_focused	keeping_brief_and_vague
		11- Maintain moral	NA	NA

Experience Phase	Awareness of situation's status	Sub-goal	Coping focus	Resilience mechanism
		standards		
8 CI Post-Debriefing	Homeostasis need awareness	06- Get relief / De-stress / Vent emotions	emotion_focused	sensemaking
		08- Understanding / Interpreting	emotion_focused	sensemaking

Table 44 Characteristics of CI Experience Phases

This table allowed to determine that the change of EP depends on the subject's concern for the adversity of the context in which he operates (C4.5 algorithm used, EP data set in ANNEX 15) :

(EP, attributes) association rules (cleaned-up, error rate = 20%)
· RESILMECA in [NA]
· SUBGOAL in [00_None_Be_ready_for_action] then **EP** = 0_Ante_Action (100,00 % of 1 examples)
· SUBGOAL in [01_Save_Optimise_efforts_resources_time] then **EP** = 0_Ante_CI (100,00 % of 1 examples)
· SUBGOAL in [02_Fulfil_duty_Complete_the_job_at_hand] then **EP** = 0_Ante_CI (50,00 % of 2 examples)
· SUBGOAL in [03_Protect_others_Secure] then **EP** = 0_Ante_CI (50,00 % of 2 examples)
· SUBGOAL in [11_Maintain_moral_standards] then **EP** = 7_CI_Post_Resumption (100,00 % of 1 examples
· RESILMECA in [distraction] then **EP** = 1_Pre_CI_Signals (100,00 % of 2 examples)
· RESILMECA in [mitigation] then **EP** = 2_Pre_CI_Tension (100,00 % of 1 examples)
· RESILMECA in [self_protection] then **EP** = 3_CI_Trauma_Exposure (100,00 % of 1 examples)
· RESILMECA in [exogenous_opportunism]
· AWARENESS in [Situational_discrepancies_awareness] then **EP** = 4_CI_Post_Tension (100,00 % of 1 examples)
· AWARENESS in [Situation_normalisation_awareness] then **EP** = 5_CI_Post_Relief (100,00 % of 1 examples)
· RESILMECA in [sensemaking]
· SUBGOAL in [06_Get_relief_De_stress_Vent_emotions] then **EP** = 6_CI_Post_Venting (50,00 % of 2 examples)
· SUBGOAL in [08_Understanding_Interpreting] then **EP** = 6_CI_Post_Venting (50,00 % of 2 examples)
· SUBGOAL in [09_Support_Help] then **EP** = 6_CI_Post_Venting (100,00 % of 1 examples)
· RESILMECA in [decision] then **EP** = 7_CI_Post_Resumption (100,00 % of 1 examples)
· RESILMECA in [keeping_brief_and_vague] then **EP** = 7_CI_Post_Resumption (100,00 % of 1 examples)

Table 45 Association rules between CI Experience Phase and their four attributes (C4.5 algorithm, error rate = 20%)

Given its apparent importance, we wanted to know if the subject's resilience mechanism was influenced by other attributes. A C4.5 decision tree was calculated (EP data set in ANNEX 15) with variable = RESILMECA, and factors = (AWARENESS, COPINGFOCUS). The following rules of association (error rate = 0%) show that resilience mechanisms are mobilised by the subject in conjunction both with AWARENESS and COPINGFOCUS :

Peritraumatic Resilience Mechanisms rules of association at CI Experience Phase level (error rate = 0%)
· COPINGFOCUS in [NA] then RESILMECA = NA (100,00 % of 7 examples)
· COPINGFOCUS in [emotion_focused]
· AWARENESS in [Duty_Awareness] **then RESILMECA** = keeping_brief_and_vague (100,00 % of 1 examples)
· AWARENESS in [MOS_MOM_limitation_risk_Awareness] **then RESILMECA** = distraction (100,00 % of 2 examples)
· AWARENESS in [Situational_discrepancies_awareness] **then RESILMECA** = exogenous_opportunism (100,00 % of 1 examples)
· AWARENESS in [Situation_normalisation_awareness] **then RESILMECA** = exogenous_opportunism (100,00 % of 1 examples)
· AWARENESS in [Homeostasis_need_awareness] **then RESILMECA** = sensemaking (100,00 % of 5 examples)
· COPINGFOCUS in [problem_focused] **then RESILMECA** = mitigation (100,00 % of 1 examples)
· COPINGFOCUS in [self_preservation_focused] **then RESILMECA** = self_protection (100,00 % of 1 examples)
· COPINGFOCUS in [duty_focused] **then RESILMECA** = decision (100,00 % of 1 examples)

Table 46 Peritraumatic Resilience Mechanisms rules of association at CI Experience Phase level (C4.5, error rate = 0%)

When the subject's focus of coping efforts is on regulating his emotions, his awareness of the situation influences the election of a peritraumatic resilience mechanism.

CI Experience Phases are resilience-focused turns in the story plot. They correspond to changes in the subject's awareness of and way of responding to the stressfulness of circumstances.

14.2.2. Finding 6 : A Critical Incident is an experience of collapse of self-agency

Present Moments # 11 and 12 correspond to CI Experience Phase 3, the traumatic exposure. In terms of recalls from Lieutenant A's episodic memory they provide the richest account of his experience, with 57 CogOps identified, 12% of the total 460, a detailed *by-the-second* account of these two PMs that must have lasted around 5 seconds altogether[312]. Given this richness, we wanted to study if resilient reactions were also narrated by the subject.

The AGENCY ordinal attribute was defined through successive iterations of interpretation of the data to characterise each CogOp. Deemed a composite concept in literature by Campbell (2009) we define "*power of agency*", or *self-agency* as an "*actor's ability to initiate and maintain a program of action*" (p. 407) by reference to Weber (1920)[313]. Categories of self-gency were defined by asking for each CogOp *Is Lieutenant A able to act upon the course of events ?* (NB: Negative values signify adverse levels):

Category	Value	Definition of the AGENCY attribute
Loss of Agency	-8	End of Agency. = a total dependence upon the course of events.
Survival	-5	Minimal Agency. = the course of events is overwhelming and only creative adaptation and hope can sustain the subject.
Manoeuvre	-2	Struggling Agency. = the subject has to constantly adapt tactically to ever changing and threatening circumstances.
Control	5	Controlled Agency. = the subject has a good control of circumstances.
Safety	8	Safe Agency. = the subject is in full control of circumstances.

Table 47 The definition of the AGENCY CogOp ordinal attribute measuring Lieutenant A's self-agency

Based on the CogOp data set (ANNEX 15) and the accuracy of the subject's recalls, the following chart shows the evolution of self-agency across Lieutenant A's episode of experience :

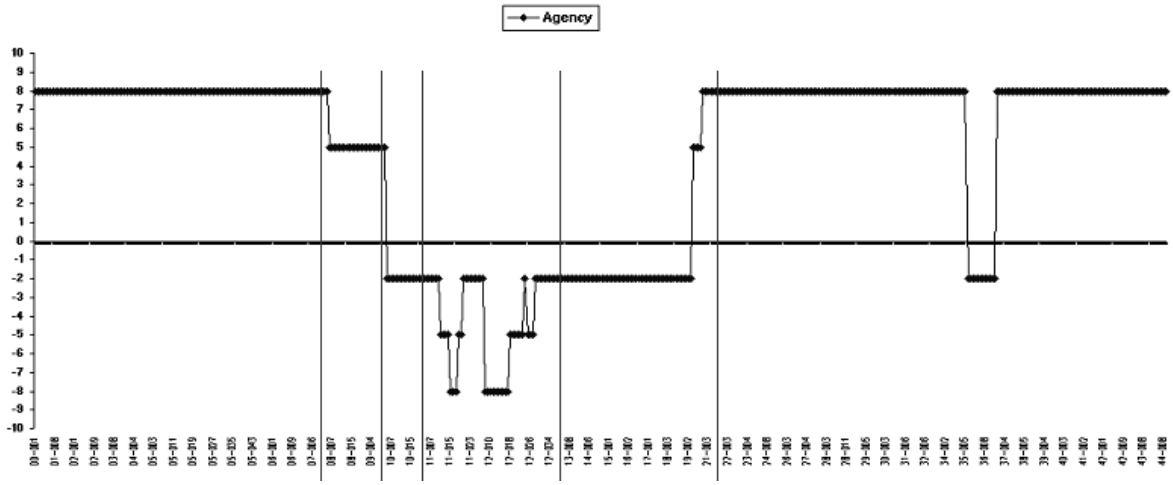


Figure 41 Lieutenant A's level of self-agency along the 460 CogOps

Lieutenant A's *profile* depicts the collapse of his power of agency from the moment he feels uncomfortable in the threatening dogs' presence (PM #8) until he recovers self-agency when the missing dog is found dying (PM #21). Several observations can be made :

- The collapse of his level of agency is progressive : falling down one level when waiting in the garden for dogs to be captured then lower when the father irrupts (PM # 10), falling to survival level when he realises the dogs are attacking, down to the loss of agency level when he experiences peritraumatic dissociation (PM # 11 & 12).

- But a struggle with circumstances characterises what is going on during PM # 11 & 12 : seeing the police's reaction, his level of agency rises back up to survival level, but falls again when he understands their inefficacy. It recovers a manoeuvre level when the subject attempts to give instructions to police officers, falls back again when he experiences another occurrence of peritraumatic dissociation and sees that bullets traversing the dogs' bodies in slow motion are inefficient. It recovers a survival level when he makes physical moves in order to avoid the dogs and when he sees them running away, wounded. Then, when he is embarked in a course of submissive action to find the missing dog (PM # 13), his level of agency remains low, at a manoeuvre level. He recovers full agency only when the dog has been found (PM # 21). If a Critical Incident is an experience of collapse of self-agency, peritraumatic resilience appears to be a struggle by which the subject tries to recover it.

- If Lieutenant A managed to resume activity after the exposure to psychological trauma this is due to the fact that his experience of trauma was not physical but psychological. The hypothesised categories presented earlier in this section could be added one

"worse" level corresponding to a "physical trauma" should Lieutenant A have been bitten by the dogs or mistakenly shot by police officers, implying the total disappearance of self-agency.

- Finally, another element must attract our attention. One hypothesis could have been that at the lowest level of Self-Agency, the "loss of agency" level, the subject's situation awareness would become nil. In fact when Lieutenant A is both attacked by the dogs and caught in the middle of the heavy gun fire, we can assume he has an accurate awareness of circumstances along with the effects of peritraumatic dissociation. He pictures exactly what is going on, understands clearly the police's incapability to kill the dogs. And, beyond doubt, he knows what the result of his situation is likely to be : he anticipates his possible death from the shooting as well as his being bitten by the dogs : "*it's not the fear of the petards, well, of the guns, it was the fear of the dogs*" (PM #12). Based on our knowledge of Lieutenant A's case, an ordinal attribute (SA) was elaborated in successive refinements of analysis of the data in order to characterise the subject's situation awareness during a Present Moment :

PM attribute	Definition and categorical and numerical values
SA	The subject's situation awareness : -7 (nil / disorientation), -3 (insufficient picture or anticipation), 0 (little), 3 (fair / partial picture and anticipation), 10 (high / good picture and anticipation

Table 48 PM attributes characterising the context of Lieutenant A's cognition (ordinal attributes in italics

In the CogOp data set, the value of SA assigned to a given PM was assigned to each CogOp within that PM. The following line chart illustrates the relation between the PM's contextual SA attribute and the CogOp-level Agency attribute[314] across Lieutenant A's episode of experience :

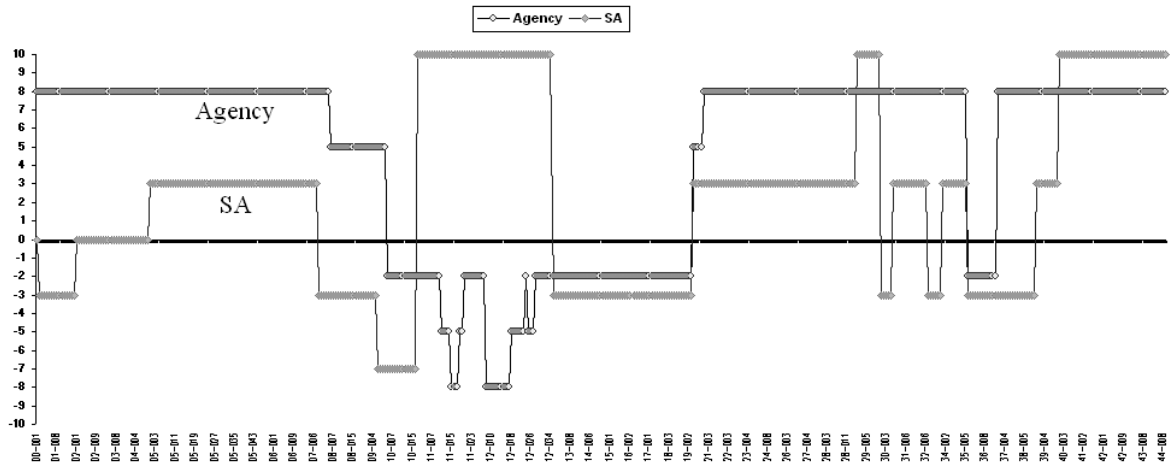


Figure 42 Comparative levels of self-agency (CogOp level) and situation awareness (contextual PM level

High SA seems associated here with a small physical perimeter, a single event at hand, the traumatic threat, peritraumatic dissociation, and intact reasoning capacities.

14.2.3. Finding 7 : PTR stems from a cognitive struggle for agency and from external support

14.2.3.1. Evidence of a cognitive struggle for self-agency

We interpreted again the narrative to search, at the fast-paced CogOp level, what kind of *phenotypic* control (*Ctrl* attribute) the subject had over his *genotypic* level of self-agency (*Agency* attribute). The Ctrl attribute was interpretatively defined in iterations as follows :

Category	Value	General definition and complementary elements for the analysis of CogOps
Struggling	9	Subject, understanding the failure of the response/defence mechanism, escalates his fight for agency by guiding others through injunctions, orders or directions, or by taking action
Margins seeking	7	Subject instruments circumstances on hand in order to try to re-augment his Margins of Manœuvre or Margins of Safety (MOM MOS
Thinking right	5	Subject evaluates the situation, risks and possibilities
Vigilance	3	Subject monitors attentively the evolution of the situation
Unsought Opportunity	2	Subject regains some control of agency by using, taking advantage of an unlooked for opportunity
Distraction	1	Subject tries to keep self-agency by changing his mind, trying to ignore the source of danger
With RSK	0	Total control of agency through ordinary **R**outines (learnt to automaticity), **S**kills (practical skills, creativity) or **K**nowledge (theoretical knowledge
Reliance	-2	Subject can only rely on hope, others or defence mechanisms to keep or regain some self-agency
Powerlessness	-9	Subject has lost all means of keeping or regaining self-agency, whether through others or by himself

Table 49 The definition of the CogOp ordinal attribute measuring Lieutenant A's by-the-second coping mode

Assigned to each CogOp, the *Ctrl* and *Agency* attributes help to understand how Lieutenant A's coping reactions varied along with his power of agency (data in ANNEX 16). The following line chart shows this relation between the Agency and Ctrl attributes. PM # 08 to PM # 12[315] are remarkable as they correspond to the pre-exposure and exposure to trauma (EP # 2 and 3) :

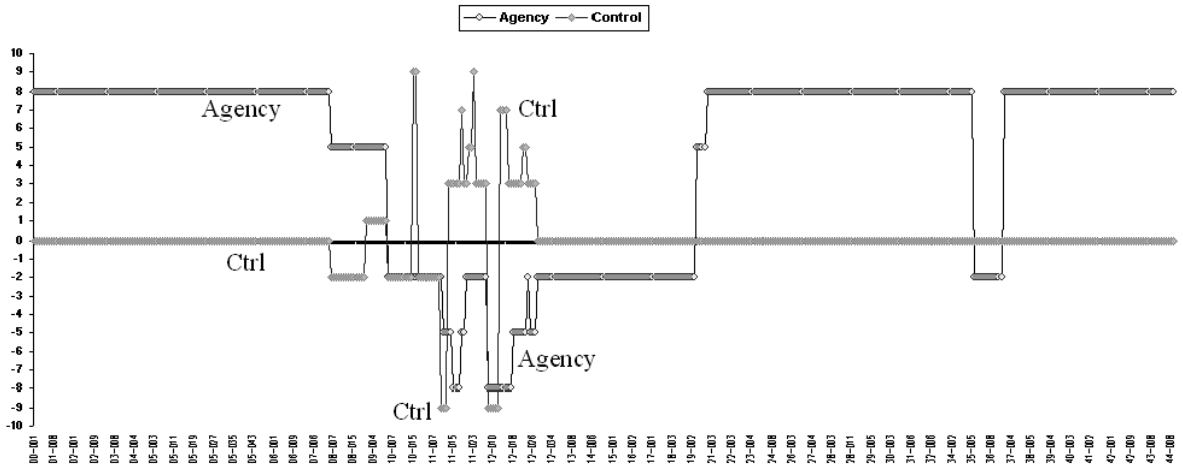


Figure 43 Timeline analysis of numerical values of the Agency and Ctrl attributes (CogOp level

We can relate these values of the two attributes to what goes on during PM #11 and PM #12. Based on the subject's narrative that provides many details of the fast pace of events, actions and cognitions that took place during the trauma exposure phase itself, the following graph relates details of Lieutenant A's by-the-second reactions to previous levels of Agency :

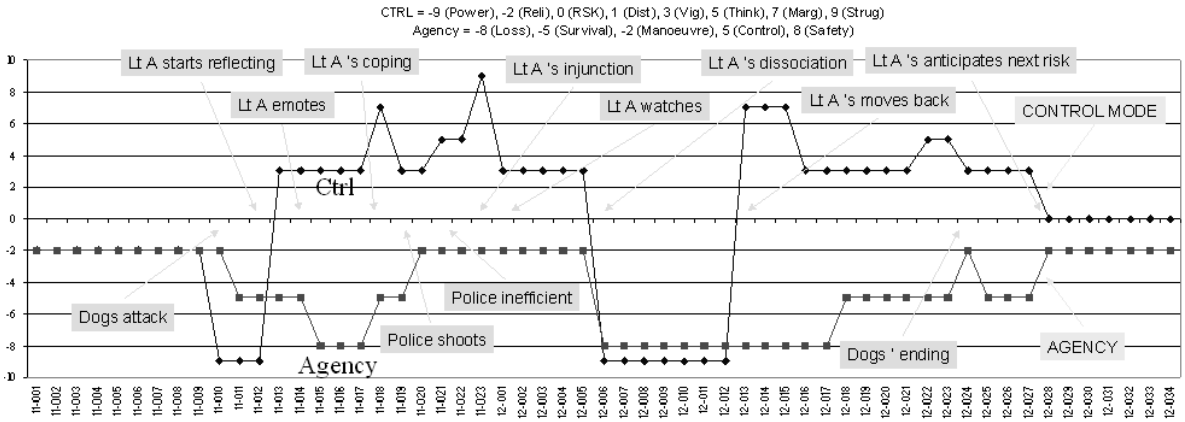


Figure 44 Details of Lieutenant A's resilient reaction at the trauma exposure phase (paralleled with the events timeline)

This graphical analysis shows Lieutenant A's reactions to adversity are quick. As soon as the dogs attack, he starts reflecting upon the situation, between active coping and planning in Carver et al.'s (1989) terms. When he experiences fright for the first time, his agency-control reaction is one of avoidance of the threat, he seeks shelter ; at this moment he has lost his power of agency. It is at this point that he regains some power of agency, though still on a low level while he is forced to manœuvre around circumstances. When he realises that police shootings are inefficient he tries to direct their action and he yells his order "*shoot ! shoot !*" to them. When he realises that the situation is hopeless he looses his

power of agency. But this is when he takes some physical moves aiming at safeguarding him (steps backwards, beside another person, hurting his hand on the side of the garden terrace, which shows the high level of energy he thrusts into these moves). Then, the dogs running away, he resorts on his vigilance and recovers some power of agency. When he understands that a dog might have run away his professional competence allows him to regain control of his course of action : danger for himself has gone away now.

This confirms that *by-the-second* coping reactions take place in the subject's cognitive process of DMA. A C4.5 analysis of the CogOp data set (ANNEX 15, n = 459, variable = *Pheno_Ctrl*, factor = *Geno_Agency*) reveals, with an error rate of 12,85%, the rules of association of a phenotypic control mode (Ctrl) with a genotypic level of agency (Agency):

. Geno_Agency in [Safety] then Pheno_Ctrl = **With RSK** (99,66 % of 294 examples [316])
. Geno_Agency in [Control] then Pheno_Ctrl = **Reliance** (51,85 % of 27 examples)
. Geno_Agency in [Manoeuvre] then Pheno_Ctrl = **With RSK** (70,37 % of 108 examples)
. Geno_Agency in [Survival] then Pheno_Ctrl = **Vigilance** (73,33 % of 15 examples)
. Geno_Agency in [Loss of Agency] then Pheno_Ctrl = **Powerlessness** (40,00 % of 15 examples).

Table 50 Rules of association between Geno_Agency and Pheno_Ctrl (C4.5 algorithm, error rate = 12,85%)

These elements evidence the existence of a cognitive, fast-paced (*by-the-second*) alternance of the subject's levels of self-agency and of coping reactions.

In the face of trauma, the subject is not defenceless, even if in short moments he looses his power of agency. This finding seems to contradict the view of a defenceless subject at the peritraumatic stage (Clervoy, 2007) but this contradiction probably does not exist as such[317].

14.2.3.2. The opportune support from others

But peritraumatic resilience (PTR) may also stem from some form of *luck*. In Lieutenant A's case, when he is (probably) still overwhelmed by the dogs' attack and the police shooting, someone shouts that a dog is missing. This opportunistically reconnects him with his duty, though in a rather passive, submissive manner. In so doing, the subject's response is adaptive. PTR can then be seen as prevention-focused self-regulation (Higgins, 1997, 1998 ; Brockner et al., 2002) : the subject has an homeostatic need for safety and his attitude is based on his moral standards (duties, obligations, and responsibilities). He seeks to avoid further trouble.

The lesson here is that in the field, reciprocal attention to team mates can ensure that when a Critical Incident occurs unexposed personnel see to help affected ones to reconnect with the requirements of their duty by proposing them a circumstantial challenge (like looking for a missing dog, searching for survivors, …).

14.3. A macrocognitive model of Decision-Making-in-Action (DMA model)

A descriptive high-level, macrocognitive model of Decision-Making-in-Action can be derived from the DM Step based global decision network, and from the result of Inter-Variability and Intra-Variability analyses :

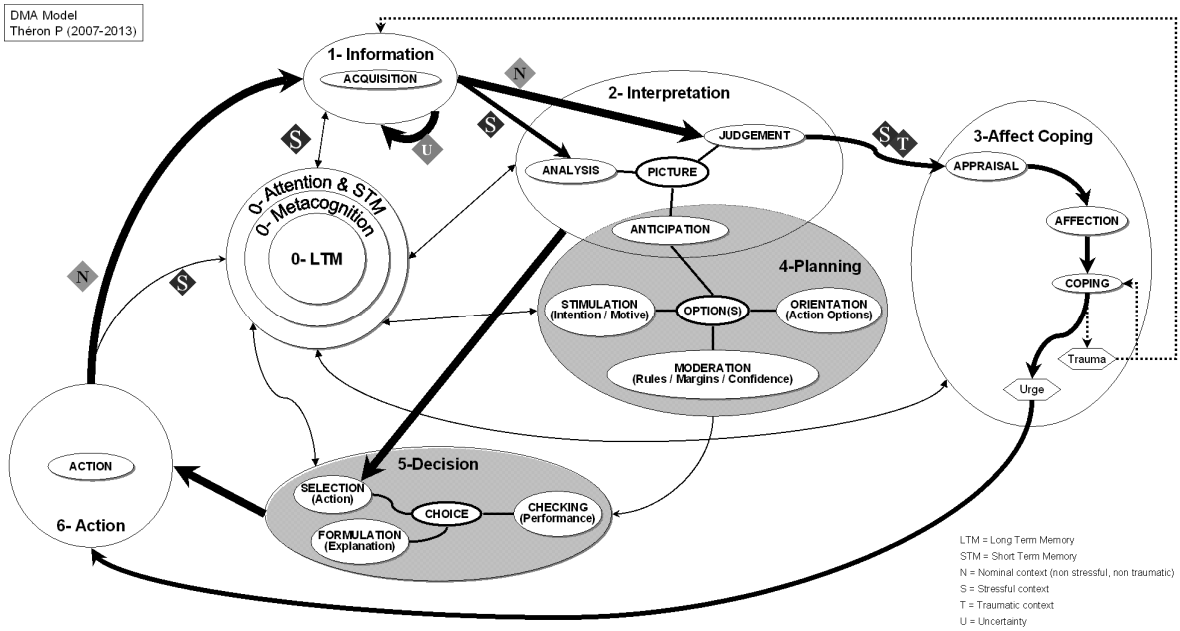


Figure 45 The high-level model of Decision-Making-in-Action (DMA Model)

This model organises Decision-Making-in-Action in successive macrocognitive functions numbered 0 to 6 : 0 = Support functions, 1 = Acquisition, 2 = Interpretation, 3 = Affect coping, 4 = Planning, 5 = Decision, 6 = Action.

It highlights the higher frequency of occurence of deliberation-based DMA patterns (boldest, black arrows) noted at the detailed PM level, and the secondary role played by affect-based DMA patterns (medium bold arrows) also noted at the PM level. It also represents the less frequent and predictable phenotypic cognitive links (thin arrows) that relate to the role played by support functions (LTM, Attention and STM, Metacognition) as noticed in decision networks. Other less frequent, less predictable links are not represented on the diagram to simplify the reading of the model. This model does not

reflect NDM researchers' finding of situation recognition as in Klein's (1998) RPD model. Lieutenant A's data can only suggest that the shortness of decisision making cycles, if not due to gaps in the subject's recalls and narrative, might be due to early situation pattern recognition.

CHAPTER 15. Discussion and conclusions

The issue of scientificity has already been debated and at this stage we do not feel that further discussion would add elements to the pros and cons of the methodological approach devised for the study, its weaknesses and also its strengths. This chapter rather discusses the topical findings of the study. First, we summarise the steps of the intellectual process of the thesis. Secondly, we reflect on the consequences of the seven findings of the analysis. Thirdly, we excerpt the key lessons from Lieutenant A's case that can constitute new requirements for CI metacognitive training. We also argue that the conceptual model on which CogOps (cognitive operations) were formed, i.e. pairs of {CogAct ; CogObj} is rudimentary and should be developed in future research. Our conclusions expose the directions of our future research work.

15.1. General review of the study

Lieutenant A's case, as studied here, is one of many similar experiences of attacks (chapter 1) endured on the line of duty by fire-fighters and, beyond, by other emergency personnel (Beignon, 2003 ; Regehr et al., 2005 ; Marmar et al., 2006 ; FBU, 2008 ; Keenan, 2008 ; IAFC, 2013). Such events are even largely under-reported (Moore-Merrel et al., 2008) and in a number of times perpetrated by or with the use of dangerous dogs. The reports of Critical Incidents referenced in our research show that the focus of authorities' concern is on the post-traumatic stage of Critical Incidents (CI) and the Post-Traumatic Stress Disorder (PTSD) syndrom for it affects staff, missions and also soldiers' families (Meredith et al., 2011). These reports also provide sometimes first-person narratives of events. These testimonies (as in IAFC's Near-Miss Incident Reports database for instance) serve mainly to identify deficiencies in the organisation or competences deployed in the field.

The clinique of trauma (chapter 2) shows that Critical Incidents (CI) such as these attacks have the potential to jeopardise missions and staff's safety in the peritraumatic moment of the intervention (Kowalski, 1995 ; Marmar et al., 2006 ; Bertrand, 2007). Chapter 3 showed that how fire-fighters manage to surmount their exposure to trauma in these circumstances remains under-studied from a cognitive perspective (Anaut, 2006 ; van der Kolk, 1997 ; Zimmer-Gembeck, 2007) beyond well-known case studies such as the Mann Gulch disaster (MacLean, 1993 ; Weick, 1993).

Beside Judgement and Decision Making (JDM) research (Shanteau, Hammond, Dawes, Lopes, Fischhof, Hogarth, Kahneman, etc.) and more qualitative methods (Maarten Shraagen et al., 2008), NDM research (Klein, Orasanu, Fischer, Zsambok, Hutton, Pruitt, Flin, Dreyfus, Rasmussen, Endsley, Etc.) has focused (chapter 4) on the cognitive study of decision-making in the field of action under stressful circumstances and has elaborated cognitive models of decision-making (chapter 4) that serve the engineering of complex computer-based environments and systems (aircraft cockpits, command posts, etc.). But NDM models have little, if not not at all, taken account of affects into the production of decisions. Peritraumatic resilience (PTR) is the capacity, the aptitude of a subject to cope with a traumatic incident in the course of action (chapter 3) and was hypothesised (chapter 4) by us to be an outcome of Decision-Making-in-Action (DMA), the individual cognitive process that controls a subject's performance within the course of a given, delimited, situated, embodied and enacted action performed in the field, not in a laboratory. Then, we asked whether fire-fighters' peritraumatic resilience could be trained (chapter 5) and summarised the current elements of metacognitive training frameworks aimed at helping fire-fighters deal better with Critical Incidents. This led us to conclude that for such frameworks to be efficient an a priori knowledge of DMA and PTR was required.

A wide variety of Cognitive Task Analysis (CTA) and other methods have been created and used (chapter 6) by NDM researchers (Ericsson & Simon, 1984 ; Rassmussen, 1985 ; Woods, 1993 ; Orasanu, 1997 ; Pascual & Henderson, 1997 ; Stokes, Kemper & Kite, 1997 ; Bisseret et al., 1999 ; Omodei et al., 2002 ; Hoffman, 2005 ; Maarten Shraagen et al., 2008). But the need to get into closer touch with subjects' inner cognition, with their first-person point of view has also been largely advocated (Banbury et al., 2002 ; Omodei et al., 1997, 2005 ; Maarten Schraagen et al., 2008) in a will to take a *radically empirical* epistemological stance (James, 1904, 1912) rather than *rationalist empiricism* (Bryman, 1984 ; Henwood & Pidgeon, 1994 ; Varela & Shear, 1999a ; Vermersch, 2006 ; den Boer, 2008) inappropriate for the study of singular cases. Hence the choice of a first-person methodology for the study of Lieutenant A's case with its five requirements : 1) to focus on an individual's cognition during a given, delimited, situated, embodied and enacted episode of experience, 2) to produce a first-person narrative of such an experience, 3) to be able to help the subject to perform recalls of his authentic (= not interpreted, not reconstructed, not theorised) episodic memories of the episode of experience, 4) to elicit cognitive operations performed by the subject during his experience through a semantic analysis process, 5) to be capable of performing both interpretative and an exploratory factor analyses out of the data extracted from the first-person narrative.

The methodology of the present study, Pheno-Cognitive Analysis (PCA), was created on two foundations : psychophenomenology (Vermersch, 2006) for data collection through the Elicitation Interview protocol (EI) described in chapters 7 and 9, and phenomenography (Marbach, 1993) described in chapter 7 as a basis for data processing (chapter 10). The EI allows the researcher to help the subject recall his episodic memories of the episode of experience under study. Episodic memories of traumatic episodes of experience are said to remain unaffected, vivid and detailed (chapter 2) for a long time (van der Kolk, 1997). Ethical precautions have been described and taken during this study to avoid affecting the subject during the EI.

Keeping in mind the criticism addressed to qualitative researchers (Bryman, 1984 ; Varela & Shear, 1999 ; Olsen, 2002 ; Cho & Trent, 2006), precautions have been taken to guarantee as far as was feasible the scientificity of this research (chapters 11).

With the reserve that other researchers would inevitably obtain a different narrative using the same Elicitation Interview (EI) protocol with the same subject, and also under the reserve that the semantic parsing and encoding of the different objects and elements describing his cognitive experience might vary, the narrative resulting from Lieutenant A's Elicitation Interview (chapter 12) has yielded an important volume of data (chapter 13, and annex volume for details). His episode of experience was interpreted as made of 9 phases of experience of the Critical Incident, and 44 Present Moments (Bergson, 1934 ; Gusdorf, 1951 ; Stern, 2004), i.e. the memorable stretches of experience recalled and narrated by the subject during the EI and considered as decision-making cycles. The episode of experience and its 44 PMs are the object of this research that was driven by the following question : *How does a fire-fighter, Lieutenant A, experiencing a Critical Incident in the course of an intervention, manage to resume and complete his action immediately after the exposure to trauma ?* (chapter 3). To answer this question, we described and studied the shape of the cognitive processes of DMA and their founding objects, cognitive operations (CogOp) conceived (chapter 7 and 10) as indissociable pairs of {cognitive act ; cognitive object}. 460 Cogops were also elicited (chapter 13) through the semantic analysis of the narrative. Decision networks representing the frequency of the chronological succession links between CogOps were calculated and helped to discover the different shapes of DMA in Lieutenant A's case (chapter 14) and a set of attributes was defined to analyse those shapes and their cognitive context through exploratory factor analyses. Seven findings were derived from the analysis : 1) Four DMA patterns were identified, in which affects play an important part in a third of all PMs, 2) DMA patterns change from one PM to the next

(Inter-Variability) and a model of inter-variability was elaborated, 3) the shape of cognitive trajectories varies within each DMA pattern (Intra-Variability) and decision trees of intra-variability were produced, 4) Recognition, memory and metacognition were found to play an unclear part in DMA, 5) CI Experience Phases are resilience-focused turns in the story plot, 6) A Critical Incident is an experience of collapse of self-agency, 7) PTR stems both from a cognitive struggle for agency and from external support. A macrocognitive model of Decision-Making-in-Action (DMA Model) is finally derived from previous analyses. It situates the role of affect within the individual decision-making process.

15.2. Metacognitive and NDM implications of the study's seven findings

Several conclusions can be drawn from the seven findings of the analysis :

- Finding 1 : There are four DMA patterns in which affects play an important part, though deliberation-based cognitive trajectories are predominant in two thirds of the 44 PMs. Affect-based cognitive trajectories intervene in CI Experience Phases presenting different levels of stressfulness (nominal, stressful, traumatic) and are not specific to the traumatic phase. Lieutenant A's case shows that cognitive models of decision-making in action (DMA) (Decision Networks) can integrate affects in their design. The macrocognitive model of DMA presented in synthesis of this study does not depict team decision-making nor does it describe tactical decision-making. From an NDM research perspective, the context of DMA is a given[318], delimited[319], situated[320], embodied[321] and enacted[322] episode of individual action, characterised in Lieutenant A's case by time-pressure in fast-paced circumstances requiring to make by-the-second decisions for himself and his mission, clear goals for the action (the intervention) and ad hoc sub-goals in its different phases, interactions with others and objects, and the subject's social background and environment defining moral and regulatory guidelines and boundaries for the subject's action. From a cognitive training standpoint, the study of Lieutenant A's case confirms the role of affect in individual decision-making. Never, or at best little mentioned in fire-fighters' regulations, training courses and exercises, it is, however, vastly acknowledged by men and officers of all ranks and experience in private conversations. Trainees, as well as more experienced fire-fighters should be told that affects signal discrepancies, hence risks in the circumstances of their action. Beside, they should be taught the four patterns of DMA that represent landmarks of the cognitive decision-making process. We hypothesise that it could be useful in the toughest situations to "keep a cool head".

- Finding 2 : DMA patterns change from one PM to the next : this phenomenon was called Inter-Variability and was analysed to be driven by the stressfulness of the circumstances experienced by the subject and the direction of the threat at hand. From an NDM standpoint it is consistent with researchers' finding that people resort on a variety of decision-making strategies along the course of a given episode of action. These patterns of DMA, and their internal shapes (cognitive trajectories discussed with the next finding) represent the way people process situations as indicated in the model of the Rules of activation of the four DMA patterns. Of course, Lieutenant A is only one case among thousands and these rules cannot pretend to generalisation, like any other result from the present research. But we point here to the necessity of performing more similar studies to improve our knowledge of these rules and others uncovered during our study. Such rules, from a cognitive training viewpoint should be taught to trainee fire-fighters. This would be only theoretical material but would also constitute landmarks in their retrospective analyses of the many interventions that confront them with CIs. Beyond, Inter-Variability tells us that affect intervenes from time to time and affect warns the subject of potential risks. However, Lieutenant A's case shows that the subject did not take the opportunity of realising he was subject to anxiety to revisit his conduct of the operation. From a metacognitive perspective, Metacognitive regulation implies not only the capacity for self-awareness but also the capacity to pose a diagnosis of one's own cognitive processing of circumstances and to readjust that process. In Lieutenant A's case, these last two functions seem not to have been performed.

- Finding 3 : The shape of cognitive trajectories varies within each DMA pattern and, beyond, across the entire episode of cognitive experience. This phenomenon was called Intra-Variability. It was shown, through an analysis using classification algorithms, that the stressfulness of circumstances was a likely factor of the election of certain types of CogOps (perception, analysis, judgement, appraisal mainly). However, the transition mechanism between CogOps is complex. First we saw that many phenotypic cognitive transitions were statistically infrequent in Lieutenant A's case. Does this hold true with any other fireman or person exposed to a CI ? Secondly, we assumed a number (about 30%) of CogOps. Possibly the subject omitted to narrate them, or he could not recall them. Possibly also we could not assume CogOps that would have changed our analysis of phenotypic transition mechanisms. Whatever the explanation, if there is any, we know that the EI protocol has its limits. In practice, EIs cannot last more than an hour. The circumstances in which they are performed are very hard to control. In

Lieutenant A's case, we had to perform it at the fire station. Contextual noises and disturbances happened. This may have disturbed the subject and broken some memory retrieval threads. Again, new pheno-cognitive studies of similar cases are needed to advance the knowledge of the factors and rules {*if Geno_DM = X and Factor {a,b, …, n} then Pheno_DM = Y*} of this phenotypic transition mechanism.

- Finding 4 : Recognition, memory and metacognition (found only as learning in our study) play an unclear part in Lieutenant A's DMA. Only few CogOps evidenced these cognitive "support" functions. The shortness (number of CogOps per PM) of cognitive trajectories is an argument in favour of a rapid or early recognition of the situation at hand by the subject. Rapid situation recognition can be assimilated to noticing features that echoe the subject's autobiographical knowledge and in Lieutenant A's case we should have found in his narrative some traces of such calls upon his memory. But as we did not the question again turns to the power of the EI to guide the subject toward the exhaustive recall of his episodic memories. Such is not the case and we must accept the incompleteness of the first-person material the EI delivers. On the opposite, this militates in favour of a rigorous observance of the guidelines set for this sort of interviews, as well as for the data processing that ensues. Similar reasoning can be held in relation to long and short term memory processes active at the actual time of the subject's experience. However, they rely upon "*under-conscious*" processes (Conway, 1995, 2001, 2005) and thus there is another limit to the pheno-cognitive study of DMA. The Elicitation Interview (EI) guidelines do not yet help to cue the corresponding probes. Work in progress at the GREX (Vermersch's Groupe de Recherche sur l'EXplicitation – EI Research Group) may in the future yield further ways to help subjects perform this sort of recalls. Complementary techniques may be needed. For instance, we saw that the re-reading in November 2007 by Lieutenant A of his resequenced narrative had triggered a few further episodic memory recalls. Other attempts by us in different contexts also tend to suggest that a re-exposure to the initial first-person narrative helps further recalls. From a methodological perspective, this is a path to explore. From a metacognitive training standpoint, this could help the subject to increase his awareness of his own *know-what* and *know-how* (Spear-Ellinwood, 2008).

- Finding 5 : CI Experience Phases are resilience-focused turns in the story plot. The apparent proximity of our findings with Higgins' (1997, 1998) concept of prevention-focused self-regulation in which "*people's safety/protection/security needs motivate them to attempt to bring their actual selves into alignment with their ought selves,*

[and] negative outcomes to be avoided" (Brockner et al., 2002, pp. 7-8) should be the object of later studies. Under this perspective, peritraumatic resilience appears as a moral standard, hence one of the three factors of self-regulation. In Lieutenant A's case, there may be a conflict between the prevention-focused and promotion-focused self-regulation attitudes. The narrative shows that the subject places at the first rank of his priorities his will to play his social role, hence a promotion-focus in self-regulation : he wants to stay in place among the policemen and firemen who are standing by the dogs. His moral and regulation standards and desire to accomplish his duty are here stronger than his need for safety. But his absence of risk awareness and of a subsequent decision to rethink the conduct of the operation, for instance to pull back, to recognise the grounds to check if security is assured and to prevent undue access to the premises (this would have prevented the irruption of the father) lies in his focus on safety for himself, under his fear of the dogs. What we understand here is that there is a conflict in self-regulation. And this conflict is detrimental to the safety of the operation, of people, and of Lieutenant A himself in fine. Self-regulation management, which can be seen as a metacognitive skill, therefore stands at the heart of peritraumatic resilience. The subject's rationality does not lie with his capacity to think. It lies with his capacity to regulate the focus of his cognition. This point is also a contribution to NDM modelling of our cognition in action. This metacognitive regulatory mechanism is part of the cognitive process of DMA, and thus was included in the DMA Model (macrocognitive functions numbered "0"). However, considering the very small, insufficient amount of related data in Lieutenant A's case, we can only suggest to perform more similar case studies and to improve the EI guidelines (New cues ? Narrative re-reading ? …) in order to help subjects to recall more memories corresponding to this regulatory mechanism (at least to verify the hypothesis of its very existence).

- Finding 6 : A Critical Incident is an experience of collapse of self-agency. Luckily, or just as van der Kolk (1997) had suggested, the episodic memories of traumatic experiences are the most vivid and detailed. What Lieutenant A's case shows is 1) that he progressively looses his capacity to act upon the course of events (and on his own course of action as his margins of safety and manœuvre diminish as the peril increases) ; 2) that he resorts on a repertory of *by-the-second* coping modes to keep or regain this capacity and the control over his course of action and his fate. From a metacognitive training perspective, this is very important. It must be taught to recruits, fire-fighters and any person due to work in dangerous settings, that unless they are seriously

physically incapacitated they still can find ways to surmount adversity, even under the prospect of death. Story-telling is probably an important way to convey this message; but alternatively pushing trainees into sharp edge exercises that allow them, risklessly, to get in touch with difficulties that require alternative thinking, the instrumentation of available artefacts into ad hoc solutions, or the awareness and exploitation of the even slightest margins of safety and manœuvre ,could give them a lived feeling of what it is like to handle tough circumstances. In NDM terms, this finding also means that there is a real interest to invest effort into research about the individual cognitive experience of trauma in action. Just like Lieutenant A's case shows, an episode of experience is made of different phases during which the subject experiences nominal, stressful and traumatic circumstances. Just like this study has been able to compare the shape and factors of the Lieutenant's cognitive activity and to unveil the components of his by-the-second struggle for self-agency, multiple studies of similar happenings would allow to draw more substantiated comparisons of the same phenomena. In terms of cognitive engineering, whether of computerised working environments or of standard operating procedures, such elements are very important as they lead to introducing such cognitive aids as a *self-agency collapse awareness indicator*, an on-hand resilience mechanism aid (awareness and choice assistant). This is the more justified in the context of very fast paced actions. Lieutenant A in PMs # 11 and 12 was able to mobilise resilience resources. In other contexts we could not say if subjects could display the same faculty without cognitive aids. The present research shows that similar case studies have to be performed and their implications in terms of cognitive engineering have to be studied.

- Finding 7 : PTR (peritraumatic resilience) stems both from a cognitive struggle for self-agency and from external social support. The vigilance and support from other crew members can help a crew member affected by trauma in action to reconnect with his duty. In the present case, someone shouting that a dog has escaped calls on the subject's ethical and regulatory background, the need to search the missing dog in order to protect other people against the impending danger. From an NDM standpoint this is an important result of this study as it shows that people's safety on the line of duty is dependent not only upon individual cognitive faculties but also on the well rehearsed and matured skill to detect crew mates in danger and to make-up a way to help them reconnect with the course of action and pull them out of the state of wobbleness[323] in which they may be. Crews' safety on the line of duty, in operation, can be at stake if the crew altogether fails to provide one another this kind of social

support. Hence the tight relationship between individual and collective peritraumatic resilience. This is what Weick's (1993) analysis of the Mann Gulch disaster points out.

15.3. Five axes for CI metacognitive training and the safety of fire-fighters

The findings of this study complement those of Driskell & Johnston (1998) and of Keenan (2008) about the need to train people for Critical Incidents in order to improve their safety on the line of duty, when confronted with attacks for instance. Metacognitive training can help to enhance their capacity for peritraumatic resilience.

Five mechanisms of peritraumatic resilience have been identified :

1. Lieutenant A's case teaches us that such a capacity stems first from an ability to better picture what is going on in the course of an intervention in the field : the experience of CIs is phased (here we identified nine phases) and we characterised each phase as a recognisable change in circumstances and in the subject's cognitive focus, goals and coping mechanisms. As far as feasible peritraumatic resilience starts with the prevention of potential trouble, provided the subject has this metacognitive capacity to analyse the course of events.

2. We have also concluded to the inability of the subject to question his attitude toward the situation and to change the conduct of the operation. We have hypothesised earlier that this may have been caused by a conflict between his self-regulation focii. His indecision can be noticed, interpreted and acted upon by the subject in order to prevent adverse happenings.

3. We have also shown that the stressfulness of the context was a driver of changes in the subject's decision-making strategies. When affect rules, the study has shown reasonable evidence of the subject's awareness of his emotions (anxiety, fear, not mentioning peritraumatic dissociation). At this stage the subject can still prevent mishappenings though Lieutenant A did not.

4. Fourth, we have presented reasonable evidence of the fast-paced cognitive struggle for self-agency that materialises in the election of *by-the-second* coping modes. The study also shows that the subject was aware of his shrinking margins of safety and manoeuvre. Peritraumatic resilience, in these moments, relied upon adaptive fast-paced

manoeuvres aimed at regaining some margin of safety by exploiting available margins of manoeuvre.

5. Fifth, we showed that social interactions have been beneficial to the subject just after the exposure to trauma as they helped him to reconnect with his duty and to come out of the state of wobbleness he was likely to be in.

Our findings point therefore to five metacognitive skills that can actively contribute to peritraumatic resilience when experiencing Critical Incidents (CI) :

	Metacognitive				
	Time scale	**Monitoring**	**Clues**	**Reaction**	**Goal**
Situation shifts management	Minute	Individual	Discrepancy	Reorientation	Prevention
Self-regulation conflict management	Minute	Individual	Indecision	Reassessment	Prevention
Affect-based decision-making warnings	Seconds	Individual	Emotion	Affect control	Prevention
By-the-second cognitive struggle for self-agency	Second	Individual	Low margins	Coping mode	Protection
Attentive crew realignment	Seconds	Crew level	Odd behaviour	Support	Reconnection

Table 51 Five CI-focused metacognitive skills

These *five CI-focused metacognitive skills* are requirements for a generic framework of metacognitive training that we derived from prior work by Driskell & johnston (1998), Cannon-Bowers & bell (1997), Fin et al. (2007), Lipshitz (1993), Orasanu & Fischer (1997), Klein (1998), Downing et al. (2007), Pruitt et al. (1997) and Flavell (1979).

Metacognitive training usually pursues :

- Three goals, from the acquisition of theoretical knowledge to rehearsed practice : 1) to develop the trainees' knowledge of the stressful / potentially traumatic environment of work (to date a form of such training occurs de facto at the BSPP as every month the dead on the line of duty are honored during morning assemblies in every fire station) ; 2) to develop their decision-making skills in critical circumstances (today, only a basic training is given to recruits and consists in rehearsing the right actions to cope with the hazards of the job, like back drafts for instance) ; 3) to build every trainee's confidence in his ability to perform under stress and in surprising critical circumstances (this type of training exists to some limited extent at the BSPP in the form of classroom training sessions, morning exercises, fire-extinguishing training, and larger civil security exercises).

- The development of three basic skills under the previous three goals : 1) the capacity to perform self-assessments of one's own cognition in action (i.e. metacognitive monitoring and interpretation) ; 2) the capacity to select the right decision-making strategy (as seen before, affect-based vs. deliberation-based) ; 3) the capacity to use one's own knowledge and experience to preserve one's own and people's safety in surprising, novel circumstances (for instance, at Mann Gulch[324] as the fire whirl is about to burst, Dodge, the head of the crew of smokejumpers burns a small patch of grass and creates the escape fire to survive the blast ; Lieutenant A, more basically, uses free space around him to escape the dogs and the police bullets ; this corresponds also to the "*selection of the level of abstraction at which to consider*" the problem at hand or the rule-based shortcuts, knowledge-based analysis and knowledge-based planning processes described by Rasmussen (1985)).

A generic framework that could allow to annalyse metacognitive training requirements is summarised in the following table. Further work is needed however in this domain as in practice the process to create learning strategies for "going meta" still has to be explored:

Goals* **TRAINING** **Skills #**	**To develop knowledge of the stressful/traumatic environment**	**To develop decision-making skills in CI conditions**	**To build one's confidence in ability to perform in CI conditions**
Self-assessment of one's cognition ≠	The mental process in CI circumstances $	Consciousness of one's cognitive activity	Rehearsing metacognitive awareness in novel situations
Selection of a decision-making strategy ≠	The repertoire of decision-making strategies ¤	Adaptation of the decision-making process according to circumstances	Experimenting decision-making strategies in novel situations £
Effective management of knowledge resources ≠	How people use their experience and knowledge to tackle CI circumstances µ	Selection and instrumentation of problem-solving RSK ¤ & artefacts	Developing creative instrumentation in novel situations
Provocative metacognitive learning strategies ↓			
GOING META %	**CONSOLIDATION**	**GENERALISATION**	**THEORISING REGULATION**
	Theoretical knowledge	Across domains of action	I and others

% Spear-Ellinwood (2008), * Driskell & Johnston (1998), # Cannon-Bowers & Bell (1997), ¤ Flin & al (2007), Orasanu & Fischer (1997), Klein (1996), $ Downing & al (1997), µ Pruitt & al (1997), £ Flavell (1979)

Figure 46 The generic framework for the analysis of metacognitive training requirements

In the particular context of the preparation for potential CIs of emergency personnel working in small teams, like fire-fighters who work in binoms or serve an engine, we suggest that **two global metacognitive skills** be considered:

- "**Individual Resilience Management**" is the metacognitive skill that allows an individual confronted with a Critical Incident to manage 1) his awareness of the situation and of its shifts, 2) his self-regulation conflicts, 3) affective signals that point to discrepancies in himself or in the course of events, 4) his power of agency. These elements of knowledge and practice can be supported by metacognitive training techniques evoked by Cannon-Bowers & Bell (1997) such as *multi-media presentations* that provide root knowledge of the basics of DMA and PTR and *cognitive feedback* from real-life interventions during which incidents (even non critical incidents) have occurred (this should be systematic[325]).

- "**Collaborative Resilience Management**" is the metacognitive skill by which, first, in the post-exposure phase of the experience of trauma in action, team mates support one another on the basis of a monitoring and response process by which unaffected team members assess each others' condition, seek signs of traumatic exposure in others, elaborate pertinents *reconnection-with-duty* sub-goals, propose them to affected team mates, and support the latter while they (try to) act upon this sub-goal. For instance, at the end of PM # 12, when Lieutenant A is still shaken by the attack and the shootings, he is fortunate that someone reconnects him with his duty by shouting that the second dog is missing, posing a risk to surrounding populations, and generating a circumstantial *search the missing dog* sub-goal. Secondly, this skill consists also in monitoring the conduct of operations in order to detect discrepancies such as, in Lieutenant A's case, his lack of initiative to restructure the measures taken to secure the garden and surroundings of the house. This is why the father could irrupt at an inopportune moment. And also, in PM #36, we note the late realisation that shootings might have hurt neighbours. This second fold relies on strong cultural norms : telling Lieutenant A he had not taken appropriate security measures is a challenge to the hierarchical relations between commanding officers and Men. Collective resilience Management should be part of *training sessions, multi-media presentations,* as well as *cognitive feedback* when significant situations or actions have been experienced in the field.

Beside, *simulations* advocated by Cannon-Bowers & Bell's (1997) are aiming at exploring, improving and assessing one's capabilities in Individual as well as Collaborative Resilience Management, and could be used. These can include classroom tabletop exercises, serious games, and when available, the use of proper simulators. *Exercises placing people in real-life like situations* should complement this panoply of techniques,

but their content should be carefully defined as dealing with CIs is psychologically challenging.

The challenge we face in future research lies in building a metacognitive learning scheme based on the principles presented by Spear-Ellinwood (2008) i.e. to create the set of metacognitive learning provocative strategies capable to engage fire-fighters to “go meta”.

15.4. The need to improve the conceptual model of CogOps

Finally, methodological conclusions can be drawn from this research. Data processing results suggest that the taxonomy of cognitive operations is more elaborate than the simple pairs of {CogAct ; CogObj} hypothesised in this study as to characterise CogOps we were led in fact to use several further concepts :

- For cognitive acts :
    - Families of acts : corresponding to the macrocognitive functions presented in the macrocognitive model of DMA.
    - Types : CogAct, that act as a fairly manipulable concept for reasoning ; however, we saw that DM Steps were better candidates for graphing global decision networks and the macrocognitive model of DMA relies upon CogObj families and DM Steps for the clarity of its reading.
    - Sub-types : CogActST, that refine the definition of CogActs and were elicited in the semantic analysis of speech clauses, but are too detailed for drawing decision networks.
- For cognitive objects :
    - Families of objects : they are the macrocognitive objects taken into consideration in DMA (Action regulation objects, objects from the world of experience, affective objects, etc.).
    - Types : CogObj, that point to more precise categories of objects taken into account in DMA (settings, self, others, situations, margins, etc.).

- Sub-types : CogObjST, that detail the definition of CogObjs and were elicited in the semantic analysis of speech clauses, but are too detailed for drawing decision networks ; CogObjST can be seen as features of the object.

- The FOCUS attribute of CogOps : CogObjST still remain concepts. For instance : the "*OTH05- PAIN - Feeling of pain / being hurt / getting wounded* " CogObjST details the "*OTHERS / ANIMALS*" CogObj and we understand that *another person or an animal feels pain*, and that for instance the subject perceives it (*PERCEIVING* CogAct). But still, we cannot say who that person or animal is. Whereas, if we associate the FOCUS attribute to the same CogObjST, for instance "*03 Mother crying / expressing her stress*", we know the subject perceives the suffering mother. Marbach's (1993) phenomenographic notation was too hard to use and read. But it identified clearly the fact that cognitive objects are composite.

PCA research must refine its model of CogObjs to integrate CogObj features describing them more completely. This might increase the amount of time spent on semantic parsing. The development of ad hoc facilitating automatic text analysis tools is an axis of research. Beside, the phenomenographic database was found to be an aid in structuring, criticising and refining the descriptive attributes and concepts we manipulated. The following diagram presents a possible future, more elaborated, conceptual model for the description of CogOps :

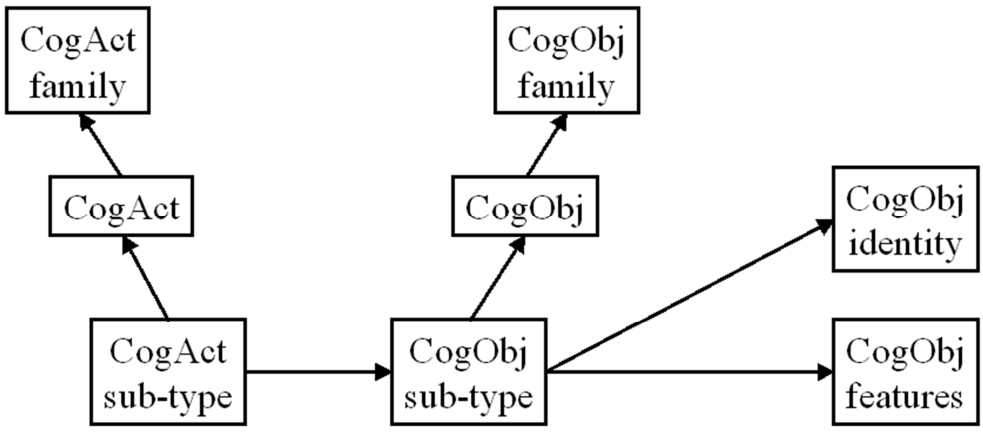


Figure 47 The future conceptual model for the description of CogOps

15.5. Conclusions and future research

15.5.1. Methodological research

We have shown, through the idiographic study of Lieutenant A's case that a pheno-cognitive analysis of the cognitive process of DMA and of peritraumatic resilience could

be performed. This was not obvious in the first place as the Elicitation Interview (EI) had been used mainly to elicit subjects' knowledge of how they learn and resolve issues in the domain of classroom education. What was accomplished in this research is bridging a traditionally qualitative and interpretative psychophenomenological approach with quantitative factor analysis techniques.

Of course, we have raised along this research report some epistemological reserves, and we have highlighted the limitations of our own work. But even with these limits in mind, what we found out is that researchers' claim for a collaboration between qualitative and quantitative traditions of research can be satisfied. There are at least three conditions for this. The definition of a methodological framework based on well documented and articulated concepts, methods and techniques is a fundamental requirement in order to satisfy both parties. Olsen (2002) advocates contradictory and diverse researchers' standpoints, i.e. epistemological pluralism, a collaboration between the two types of scientists. And, as a lesson from this research, the qualitative side of a study must deliver data usable by scientists seeking to perform at least categorical data analyses and factor analyses. Semantic analysis was the indispensable bridge between the two traditions. Time consuming and still unsupported by ad hoc automatic text analysis tools, this is one of our next endeavour and this epistemological bridge is an important aspect of future pheno-cognitive research work. Another axis is the improvement of the EI protocol as already discussed in previous sections.

In the same line of methodological developments, the second point is that when studying the Intra-Variability of the pattern of DMA's cognitive processes, we have highlighted the central importance of the transition mechanism between cognitive operations. This idea is not new and it should be paralleled with current work in neurosciences (Varela,1999 ; Dehaene et al., 2006 ; Freeman, 2007) on the transition mechanism between the large-scale cortical synchronisations that give life to our cognitive operations and sensori-motor actions, "*transient networks that integrate distributed brain processes into highly ordered cognitive functions*" (Lutz et al., 2002). Neurophenomenology (Ellis, 1999 ; Varela, 1999 ; Lutz et al., 2002 ; Thompson, 2007 ; den Boer, 2008) was conceived to bridge the gap between psychophenomenological research and neuroscience through combining first-person cognitive testimonies and brain imagery of controlled experiments. Already, Elicitation Interviews have been used for such purposes (Thompson, 2007). If neurosciences underline the complexity of the brain processes that elect a mental operation, the "neurophenomenological cooperation" is a source of progress in future

cognitive research. The PCA protocol is a candidate instrument to perform Elicitation Interviews about real-life episodes of experience in conjunction with brain imagery. The study of the correlation between brain images of the mental activity of recollecting episodic memories and the cognitive operations semantically derived from the narrative would bring further progress in PCA research. Possibly with regards to the assumption of unnarrated CogOps and the elaboration of the cognitive taxonomy.

15.5.2. Topical research

Our primary topical conclusion and axis of future research has to do with metacognitive training and its short term application to improving fire-fighters' safety on the line of duty.

We have elicited two *global metacognitive skills* that contribute to the development of peritraumatic resilience in people working in dangerous settings, such as fire-fighters. The generic CI-focused metacognitive training framework presented here to emergency response organisations, as well as to all organisations concerned with the management of emergency situations, even in more mundane areas of civil life, acts as a map to specify and organise a metacognitive training plan. This outcome has already practical applications opportunities in our daily activities. However, as ne noted before, the challenge is to elaborate metacognitive learning schemes that engage fire-fighters, or other people involved in dangerous activities, into "going meta" (Spear-Ellinwood, 2008). This requires a long-term partnership with an emergency response organisation such as the BSPP.

In a recent meeting (June 2013), the BSPP's (Paris Fire brigade) Bureau of Training Engineering showed interest for this framework and our findings in two areas :

- <u>The improvement of fire-fighters' safety on the line of duty</u> : Post-intervention debriefing and lesson learning are a BSPP regulatory prescription. In practice they are oriented toward the analysis of events along their timeline, the collective behaviours and in case of incidents individual behaviours, the causes of incidents, the domains in which progress should be made. The report extracts posted on the IAFC's web site (IAFC, 2013a) show a similar orientation. But, like the SNCF (French Railways company) who asked us to inquire into the cognitive underpinnings of an accident in 2005 (Théron, 2005) when the official report concluded merely to trees blocking the view of station officers and a human error, a very traditional conclusion in accident reports, the BSPP has an interest in understanding staff behaviour when Critical Incidents occur in the field. The primary reason is the institution's concern for their

personnel's safety in action. This axis of research has not yet been explored but was found to be of the highest interest given current legislative obligations placed upon employers to guarantee collaborators' safety, including the BSPP.

- The recruitment process : People applying for fire-fighting jobs are assessed for their capacity to stand the hardships they will inevitably face in their career. If so far the recruitment process has been fairly reliable, the current 25 to 30% first-year attrition ratio signifies however the need to add new facets to information, evaluation and selection methods in use. For instance : the creation of visual material and stories for information, and metacognitive games for evaluation and selection. The five CI-focused metacognitive skills could be part of such tests. This area of research has to be explored.

Secondly, we have seen that Intra-Variability decision trees deliver association rules that could feed inference engines, and we assume this approach could help to develop, in video games and behavioural simulators, *cognitively autonomous computer agents*[326] that could display unpredictable (by the player) and adaptive behaviours founded on sophisticated patterns of autonomous deliberative and affective cognitive reactions. In this area, Wang (2009) highlights that "*Despite the fact that the origin of software agent systems has been rooted in autonomous artificial intelligence and cognitive psychology, their implementations are still based on conventional imperative computing techniques rather than autonomous computational intelligence.*". The link between our work and cognitive architectures[327] should now be studied. This strand of research could yield new means to train people for potential Critical Incidents. It has to be explored.

Part 5. APPENDICES

CHAPTER 16. Bibliography

Allais, M. (1953). Le comportement de l'homme rationnel devant le risque : Critique des postulats et axiomes de l'école américaine. *Econometrica*, 21, pp. 503–546.

Allport, G. W. (1962). The general and the unique in psychological science. *Journal of Personality*, 30, pp. 405-422.

Amalberti, R. (2001). The paradoxes of almost totally safe transportation systems. *Safety Science*, 37, pp. 109-126.

Amano, K. (1999). Improvement of schoolchildren's reading and writing ability through the formation of linguistic awareness. In Y. Engeström, R. Miettinen & R-L. Punamäki (Eds), *Perspectives on Activity Theory*. Cambridge University Press, pp. 183-205.

Anaut, M. (2006). La résilience au risque de la psychanalyse. Ou la psychanalyse au risque de la résilience ?. In B. Cyrulnik & P. Duval (Eds). *Psychanalyse et Résilience*. Paris: Odile Jacob.

Anderson, M. L., Oates, T., Chong, W. & Perlis, D. (2006). The metacognitive loop I: Enhancing reinforcement learning with metacognitive monitoring and control for improved perturbation tolerance. *Journal of Experimental and Theoretical Artificial Intelligence*, 18(3), pp.387–411.

Andrade, J. & May, J. (2004). *Instant Notes in Cognitive Psychology*. Abingdon, UK: Garland Science / BIOS Scientific Publishers.

Annett, J. (1997). Analysing team skills. In R. Flin, E. Salas, M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Thems and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

APA. (2013). *The Road to Resilience*. Available at http://www.apa.org/helpcenter/road-resilience.aspx, read on July 25th, 2013.

Arnold, M. B. (1960). Emotion and Personality. *Psychological Aspects*, 1.

Bachelard, G. (1932). *L'intuition de l'instant*. Paris: Stock.

Bachelard, G. (1939). Instant poétique et instant métaphysique. *Messages: Métaphysique et poésie*, 2.

Banakou, D. Groten, R. & Slater, M. (2013). Illusory ownership of a virtual child body causes overestimation of object sizes and implicit attitude changes. *Proceedings of the*

National Academy of Sciences of the United States of America, available online at http://www.pnas.org/content/early/2013/07/10/1306779110.

Banbury, S., Dudfield, H. & Lodge, M. (2002). Development and Preliminary Validation of a Cognitive Model of Commercial Airline Pilot Threat Management Behaviour. In C. W. Johnson (Ed.) *Human Decision Making and Control*, Proceedings of the 21st European Conference on Human Decision Making and Control, Scotland : University of Glasgow.

Barclay, C. R. (1995). Autobiographical remembering: Narrative constraints and objectified selves. In D. C. Rubin (Ed). *Remembering Our Past. Studies in Autobiographical Memory*. Cambridge University Press.

Bartlett, F. C. (1932). *Remembering: A study in experimental and social psychology*. Cambridge UK: Cambridge University Press.

Bateson, G. (1972). *Steps to an Ecology of Mind*. San Francisco: Chandler Publication Group.

Batha, K. & Carroll., M. (2007). Metacognitive training aids decision making. *Australian Journal of Psychology*, 59(2), pp. 64 – 69.

Bailey, K. D. (1994). *Typologies and Taxonomies: An introduction to classification techniques*. Thousand Oaks: Sage.

Béguin, P. & Rabardel. P. (2000). Designing for Instrument-Mediated Activity. In *Scandinavian Journal of Information Systems*, 12, pp. 173-190.

Beignon, D. (2003). *Le soutien psychologique des Sapeurs-Pompiers face à l'insécurité*. Paris: BSPP. Mémoire du Diplôme de Qualification Militaire. Retrieved from the Internet.

Bergson, H. (1934). *La pensée et le mouvement*. Paris: Alcan.

Berking, M., Meier, C. & Wupperman, P. (2010). Enhancing Emotion-Regulation Skills in Police Officers: Results of a Pilot Controlled Study. Behavior Therapy, 41, pp. 329–339.

Bertrand, M. (2007). Situations extrêmes : le difficile chemin de la subjectivation. In A. E. Aubert & R. Scelles (Eds). *Dispositifs de soin au défi des situations extrêmes*. Edition érès.

Bisseret, A., Sebillotte, S. & Falzon, P. (1999). *Techniques pratiques pour l'étude des activités expertes*. Toulouse : Octarès.

Blickensderfer, E., Cannon-Bowers, J. A. & Salas, E. (1998). Cross-Training and Team Performance. In J. A. Cannon-Bowers & E. Salas (Eds.). *Making Decisions Under Stress. Implications for Individual and Team Training*. Washington: American Psychological Association.

Bloch, M. (2006). *L'anthropologie cognitive à l'épreuve du terrain. L'exemple de la théorie de l'esprit*. Paris: Collège de France / Fayard.

Boyd, N. G., Lewin, J. E. & Sager, J. K. (2009). A model of stress and coping and their influence on individual and organizational outcomes. *Journal of Vocational Behavior*, 75(2009), pp. 197–211.

Brehmer, B. (1990). Strategies in real-time dynamic decision making. In R. Hogarth (Ed). *Insights in Decision Making: A Tribute to Hillel J. Einhorn*. Chicago: University of Chicago Press.

Breiman, L. (2001). Random Forests. *Machine Learning*, 45, pp. 5-32.

Brentano, F. (1874). *Psychologie vom empirischen standpunkt*. Leipzig.

Brewer, W. F. (1995). What is recollective memory ?. In D. C. Rubin (Ed). *Remembering Our Past. Studies in Autobiographical Memory*. Cambridge University Press.

Brewin, C. (2003). *Postraumatic Stress Disorder: Malady or Myth?* USA:Yale University Press.

Brockner, J., Paruchuri, S., Idson, L. C. & Higgins, E. T. (2002). Regulatory Focus and the Probability Estimates of Conjunctive and Disjunctive Events. *Organizational Behavior and Human Decision Processes*, 87(1), pp. 5–24.

Bruner, J. & Fleischer Feldman, C. (1995). Group narrayive as a cultural context of autobiography. In D. C. Rubin (Ed). *Remembering Our Past. Studies in Autobiographical Memory*. Cambridge University Press.

Bryman, A. (1984). The Debate about Quantitative and Qualitative Research: A Question of Method or Epistemology? *The British Journal of Sociology*, 35(1), pp. 75-92.

Bujarski, M., Hildebrand-Nilshon, M. & Kordt, J. (1999). Psychomotor and socioemotional processes in literacy acquisition: Results of an ongoing case study involving a nonvocal cerebral palsic young man. In Y. Engeström, R. Miettinen & R-L. Punamäki (Eds), *Perspectives on Activity Theory*. Cambridge University Press, 1999, pp. 206-227.

Cacciabue P.C. & Hollnagel, E. (1995). Simulation of Cognition: Applications. In J.M. Hoc, P.C. Cacciabue, & E. Hollnagel (Eds.), *Expertise and Technology: Cognition and Human-Computer Cooperation*, pp. 55–73. Lawrence Erlbaum Associates.

Campbell, C. (2009). Distinguishing the Power of Agency from Agentic Power: A Note on Weber and the “Black Box” of Personal Agency. *Sociological Theory*, 27(4), pp. 407-418.

Cannon-Bowers, J. A. & Bell, H. (1997). Training Decision Makers for Complex Environments: Implications of the Naturalistic Decision Making Perspective. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Cannon-Bowers, J. A. & Salas, E. (1998). *Making Decisions Under Stress. Implications for Individual and Team Training*. Washington: American Psychological Association.

Cannon-Bowers, J. A., Burns, J. J., Salas, E. & Pruitt, J. S. (1998). Advanced Technology in Scenario-Based Training. In J. A. Cannon-Bowers & E. Salas (Eds.). *Making Decisions Under Stress. Implications for Individual and Team Training*. Washington: American Psychological Association.

Carver, C. S., Scheier, M. F. & Weintraub, J. K. (1989). Assessing Coping Strategies: A Theoretically Based Approach. *Journal of Personality and Social Psychology*, 56(2), pp.267-283.

Cho, J. & Trent, A. (2006). Validity in qualitative research revisited. *Qualitative Research*, 6; pp. 319-340.

Clervoy, P. (2007). *Le syndrome de Lazare. Traumatisme psychique et destinée*. Paris: Albin Michel.

Coates, B. E. (1997). Toward an understanding of stress on organizational social systems in complex, dynamic environments. In R. Flin, E. Salas, M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Thems and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Cohen, M. D., Marchand, J. G. & Olson, J. P. (1972). A garbage can model of organizational choice. *Administrative Science Quarterly*, 17, pp. 1–25.

Colman, A. M., Ed. (2006). *A Dictionary of Psychology*. Oxford University Press, second edition.

Conway, M. A. (1995). Autobiographical Knowledge and Autobiographical Memories. In D. C. Rubin (Ed). *Remembering Our Past. Studies in Autobiographical Memory*. Cambridge University Press.

Conway, M. A. (2001). Sensory-perceptual episodic memory and its context: autobiographical memory. In A. Baddeley, M. Conway & J. Aggleton (Eds). *Episodic Memory. New directions for research*. Oxford University Press.

Conway, M. A. (2004). Memory: Autobiographical. Entry in R. L. Gregory (Ed.). *The Oxford Companion to the Mind*. Oxford University Press, Second Edition, pp. 562-564.

Copans, J.. (2005). *L'enquête anthropologique de terrain*. Paris: Armand Colin.

Coulthard, M. (1985). *An introduction to discourse analysis. Applied linguistics and language studies*. Longman, second edition.

Cox, M. T. (2005). Metacognition in computation: A selected research review. *Artificial Intelligence*, 169, p.104–141.

Cox, T., Griffiths, A. & Rial-González, E. (2000). *Research on Work-related Stress*. European Agency for Safety and Health at Work.

Cramér, H. (1946). *Mathematical Methods of Statistics*. Princeton: Princeton University Press.

Crandall B, Klein G. Hoffman RR. (2006). *Working minds: a practitioner's guide to cognitive task analysis*. Cambridge (MA : The MIT Press.

Creswell, J. W. (2007). *Qualitative Inquiry & Research Design. Choosing Among Five Approaches*. Sage Publications. Second Edition.

Crocq, L. (2007a). Violence, victime et société. In L. Crocq (Ed). *Traumatismes psychiques. Prise en charge psychologique des victimes*. Issy-Les-Moulineaux : Elsevier-Masson SAS.

Crocq, L. (2007b). Clinique de la réaction immédiate. In L. Crocq (Ed). *Traumatismes psychiques. Prise en charge psychologique des victimes*. Issy-Les-Moulineaux : Elsevier-Masson SAS.

Cyert, R. M. & March, J. G. (1963). *A Behavioral Theory of the Firm*. Englewood Cliffs: Prentice Hall.

Cyrulnik, B. (2006). Introduction. In B. Cyrulnik & P. Duval (Eds). *Psychanalyse et Résilience*. Paris: Odile Jacob.

Dainton, B. (2000). *Stream of Consciousness: Unity and Continuity in Conscious Experience*. London: Routledge.

Dahlquist, L. M., Herbert, L. J., Weiss, K. E. & Jimeno, M. (2010). Virtual-Reality Distraction and Cold-Pressor Pain Tolerance: Does Avatar Point of View Matter?. In Cyberpsychology, Behavior, and Social Networking, 13(5), pp. 587-591.

Damasio, A. R. (1994). *Descartes'Error. Emotion, Reason, and the Human Brain*. Putnam Books. NB : As I had that version only on hand, I refer here, in fact, to the French

translation of this book by Marcel Blanc : Damasio, A. R. (2006). *L'erreur de Descartes. La raison des émotions*. Paris: Odile Jacob.

Dayan, J. & Olliac, B. (2010). From hysteria and shell shock to posttraumatic stress disorder: Comments on psychoanalytic and neuropsychological approaches. *Journal of Physiology*. 104, pp. 296-302.

Dehaene, S. Changeux, J-P., Naccache, L., Sackur, J. & Sergent, C. (2006). Conscious, preconscious, and subliminal processing: a testable taxonomy. *Trends in Cognitive Sciences*, 10(5), pp. 204-211.

Dekker, S. (2002). *The Field Guide to Human Error Investigations*. Aldershot: Ashgate.

den Boer, J. A., A.A.T. Reinders, S. & Glas, G. (2008). On Looking Inward. Revisiting the Role of Introspection in Neuroscientific and Psychiatric Research. *Theory & Psychology*, 18(3), pp. 380–403.

Downing, K., Ho, R., Shin, K., Vrijmoed, L. & Wong, E. (2007). Metacognitive development and moving away. *Educational Studies*, 33(1), pp. 1–13.

Driskell, J. E. & Johnston, J. H. (1998). Stress Exposure Training. In J. A. Cannon-Bowers & E. Salas (Eds.). *Making Decisions Under Stress. Implications for Individual and Team Training*. Washington: American Psychological Association.

DSM-IV : Diagnosis and statistical Manual of Mental Disorders, 4th revision, 1994. American Psychiatric Press, 1995.

Duchet, C. (2007). Intervention psychothérapeutique post-immédiate. In L. Crocq (Ed). *Traumatismes psychiques. Prise en charge psychologique des victimes*. Issy-Les-Moulineaux : Elsevier-Masson SAS.

Edward, K-L. (2005). The phenomenon of resilience in crisis care mental health clinicians. *International Journal of Mental Health Nursing*, 14), pp. 142–148.

Edwards, D. & Potter, J. (1992). The Chancellor's Memory: Rhetoric and Truth in Discursive Remembering. *Applied Cognitive Psychology*, 6, pp. 187-215.

Edwards, W. (1954). The theory of decision making. *Psychological Bulletin*, 51, pp. 380.417.

Elin, M. R. (1997). An Integrative Developmental Model for Trauma and Memory. In P. S. Appelbaum, L. A. Uyehara & M. R. Elin (Eds). *Trauma and Memory. Clinical and legal controverses*. Oxford University Press.

Ellis R. D. (1999). Integrating neuroscience and phenomenology in the study of consciousness. In *Journal of Phenomenological Psychology*, 30(1), pp. 18-47.

Emerson, R. (1962). Power dependence relations. *American Sociological Review*, 27, pp.31–41.

Endsley, M. R. (1995). Measurement of situation awareness in dynamic systems. *Human Factors*, 37(1), pp. 65-84.

Endsley, M. R. (1997). The Role of Situation Awareness in Naturalistic Decision Making. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Engeström, Y. (1999). Innovative learning in work teams. In Y. Engeström, R. Miettinen & R-L. Punamäki (Eds), *Perspectives on Activity Theory*. Cambridge University Press, pp. 377-404.

Ericsson, K. A. & Simon, H. A. (1984). *Protocol analysis : verbal reports as data*. Cambridge, MA: The MIT Press, Revised edition of 1993.

Everall, R. D., Altrows, K. J. & Paulson, B. L. (2006). Creating a future: A study of resilience in suicidal female adolescents. *Journal of Counseling and Development*, 84, pp. 461-470.

Eysenck, M. W. & Keane, M. T. (2005). *Cognitive Psychology. A Student's Handbook.* Hove, UK: Psychology Press.

Festinger, L. (1964). *Conflict, decision and dissonance*. Stanford University Press.

FBU. (2005). *Attacks on firefighters*. UK: Fire Brigades Union, April 2005. Available at www.fbu.org.uk.

FBU. (2008). *Easy targets ? Tackling attacks on fire crews in the UK*. UK: Fire Brigades Union, February 2008. Available at http://www.fbu.org.uk/?p=4614.

Fisher, R.P. & Geiselman, R.E. (1992). *Memory enhancing techniques for investigative interviewing: The Cognitive Interview.* Springfield III.: Charles C. Thomas.

Fivush, R., Haden, C. & Reese, E. (1995). Remembering, recounting and reminiscing: The development of autobiographical memory in social context. In D. C. Rubin (Ed). *Remembering Our Past. Studies in Autobiographical Memory*. Cambridge University Press.

Flin, R., Salas, E., Strub, M. & Martin, L., Eds. (1997). *Decision Making Under Stress. Emerging Themes and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Flin, R., Youngson, G. & Yule, S. (2007). How do surgeons make intraoperative decisions? *Qual. Saf. Health Care,*16, pp. 235-239.

Folkman, S. & Lazarus, R. S. (1980). An analysis of coping in a middle-aged community sample. *Health Soc Behav*, 21, pp. 219-239.

Franklin, S. (2003). IDA: A Conscious Artifact?. In *Journal of Consciousness Studies*, 10, pp. 47-66.

Franklin, S. & Patterson, F. G. (2006). *The LIDA architecture: Adding new modes of learning to an intelligent, autonomous, software agent*. Paper presented at Integrated Design and Process Technology, IDPT-2006.

Freeman, W. J. (2007). Definitions of state variables and state space for brain-computer Interface. Part 1. Multiple hierarchical levels of brain function. *Cogn Neurodyn*, 1, pp. 3-14.

Frijda, N. H. (1993). The place of appraisal in emotion, *Cognition & Emotion*, 7(3-4), pp. 357-387.

GAIN (2004). *The Other End of the Radio: Identifying and Overcoming Common Pilot/Controller Misconceptions*. Interim Report. GAIN Working Group E: Flight Ops/ATC Ops Safety Information Sharing, September 2004.

Gallagher, S. & Zahavi, D. (2007). *The phenomenological mind. An introduction to philosophy of mind and cognitive science*. Routledge.

Gallet, J-C. (2006). *La lutte contre le feu menée par les Sapeurs-Pompiers de Paris au XIXème siècle*. Paris: Collège Interarmées de Défense. Unpublished dissertation.

Gardner, G. (2001). Unreliable memories and other contingencies: problems with biographical knowledge. *Qualitative Research*, 1(2), pp. 185-204.

Gergen, K. J. (1994). Mind, text and society: Self-memory in social context. In U. Neisser & R. Fivush (Eds). *The remembering self. Construction and accuracy in the self-narrative*. Emory Symposia in Cognition 6. Cambridge University Press.

Gerrard, N., Kulig, J. & Nowatzki, N. (2004). What Doesn't Kill You Makes You Stronger: Determinants of Stress Resiliency in Rural People of Saskatchewan, Canada. *The Journal of Rural Health*, 20(1), pp. 59-66.

Gershuny, B. S. & Thayer, J. F. (1999). Relations among psychological trauma, dissociative phenomena, and trauma-related distress: a review and integration. *Clinical Psychology Review*, 19(5), pp. 631-657.

Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Boston : Houghton Mifflin.

Ginsburg, C. (1999). *Body-image, Movement and Consciousness: Examples from a somatic practice in the Feldenkrais Method*. In F. Varela & J. Shear, The View from Within. First-person approaches to the study of consciousness, Journal of Consciousness Studies, 6, N°2-3, 1999, pp79-91

Goffman, E. (1968). *Asylums: Essays on the social situation of mental patients and other inmates*. Chicago: Alding Publishing Co.

Goodman, L. & Kruskal, W. (1954). Measures of Association for Cross Classifications. *Journal of the American Statistical Association*, 49(268), pp. 732-764.

Gregory, R. L., Ed. (2004). *The Oxford Companion to the Mind*. Oxford University Press.

Gross, R. (2009). *Psychology. The science of mind and behaviour*. Hodder Arnold.

Guitton-Cohen Addad, C. (1988). *Instant et processus. Analogie en thérapie familiale systémique*. Paris: Editions ESF.

Gusdorf, G. (1951). *Mémoire et personne. Tome premier : La mémoire concrète*. Paris: Presses Universitaires de France.

Hammond, J. & Brooks, J. (2001). The World Trade Center Attack. Helping the helpers: the role of critical incident stress management. *Critical Care*, (5), pp. 315-317.

Hastie, R. (2001). Problems for Judgement and Decision Making. *Annual Review of Psychology*, 52, pp. 653-683.

Henwood, K. & Pidgeon, N. (1994). Beyond the Qualitative Paradigm: A Framework for Introducing Diversity within Qualitative Psychology. *Journal of Community & Applied Social Psychology*, 4, pp. 225-238.

Higgins, E. T. (1997). Beyond pleasure and pain. *American Psychologist*, 52, pp.1280–1300.

Higgins, E. T. (1998). Promotion and prevention: Regulatory focus as a motivational principle. In M. P. Zanna (Ed.), *Advances in experimental social psychology*, 32, pp. 1–46, New York: Academic Press.

Hockey, G. R. J., Ed. (1983). *Stress and Fatigue in Human Performance*. John Wiley & Sons.

Hoffman, R. R. (2005). Protocols for Cognitive Task Analysis. Florida: Institute for Human & Machine Cognition (Study sponsored by the US Army Research Laboratory).

Hoffman, R. R. (2008). Influencing versus Informing Design, Part 2: Macrocognitive Modeling. *IEEE Intelligent Systems*, 23(6), pp. 86-89.

Hollnagel, E. (1991). The Phenotype of Erroneous Actions: Implications for HCI Design. In G. R. S. Weir & J. L. Alty (Eds.). *Human-Computer Interaction and Complex Systems*. Academic Press.

Hollnagel, E. (1998). Context, cognition, and control. In Y. Waern, (Ed.). *Co-operation in process management. Cognition and information technology*. London: Taylor & Francis.

Hollnagel, E. (2000). Modelling the orderliness of human action. In N. B. Sarter & R. Amalberti (Eds.), *Cognitive engineering in the aviation domain*. Mahwah, NJ: Lawrence Erlbaum Associates.

House of Commons. (2013). *Dog Control and Welfare. Seventh Report of Session 2012–13. Volume I: Report, together with formal minutes, oral and written evidence*. House of Commons Environment, Food and Rural Affairs Committee.

Husserl, E. (1977). *Phenomenological Psychology. Lectures, Summer Semester, 1925*. Translated by John Scanlon. The Hague: Martinus Nijhoff.

Hutchins, S. G. (1997). Decision-Making Errors Demonstrated by Experienced Naval Officers in a Littoral Environment. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Hutton, R. J. B. & Klein, G. (1999). Expert Decision Making. *Inc. Syst Eng*, 2, pp. 32-45.

IAFC. (2013). *Call to Action: Stand Up for Safety*. Retrieved from the Internet, July 24th, 2013, at http://www.iafc.org.

IAFC. (2013a). *Five Critical Incident Reports*. Retrieved from the Internet on July 24th, 2013, at http://www.firefighternearmiss.com:7800/search?q=%22critical+incident%22&filter=0&client=iafc_frontend&proxystylesheet=iafc_frontend&site=iafc&output=xml_no_dtd.

Idzikowski, C. & Baddeley, A. D. (1983). Fear and Dangerous Environments. In G. R. J.Hockey (Ed). *Stress and Fatigue in Human Performance*. John Wiley & Sons.

Jacelon, C. S. (1997). The Trait and Process of Resilience. *Journal of Advanced Nursing*, 25, pp. 123-129.

James, W. (1890). *The Principles of Psychology*. Mineola: Dover Publications.

James, W. (1904). A World of Pure Experience. *The Journal of Philosophy, Psychology and Scientific Methods*, 1(20), pp. 533-543.

James, W. (1912). *Essays in Radical Empiricism*. London: Longmans, Green & C^{y}.

Janet, P. (1889). *L'automatisme psychologique*. Paris: L'Harmattan, 2005.

Jenkins, J. J. (1979). Four points to remember: A tretrahedal model of memory experiments. In L. S. Cermak & F. I. M. Craik (Eds), *Levels of processing in human memory*, Hillsdale, NJ: Lawrence Erlbaum, pp. 429-446.

Kapa, E. (2007). Transfer from structured to open-ended problem solving in a computerized metacognitive environment. *Learning and Instruction*, 17, pp. 688-707.

Kedia, M. (2009). Understanding dissociation: an important element in the treatment of trauma. *L'évolution psychiatrique*, 74, pp. 487-496.

Keen, E. (1975). *A Primer in Phenomenological Psychology*. New-York: Holt, Rinehart and Winston, Inc.

Keenan, D. (2008). *Rescuing the rescuer: Early psychological intervention for firefighters following exposure to potentially traumatic line-of-duty events*. PhD Thesis, University of South Australia, School of Psychology, Division of Education, Arts & Social Sciences. Retrieved from the Internet.

Kennedy, F., Clarke, B., Stopa, L., Bell, L., Rouse, H., Ainsworth, C., Fearon, P. & Waller, G. (2004). Towards a cognitive model and measure of dissociation. *Journal of Behavior Therapy and Experimental Psychiatry*, 35, pp. 25-48.

Kindt, M. & van den Hout, M. (2003). Dissociation and memory fragmentation: experimental effects on meta-memory but not on actual memory performance. *Behaviour Research and Therapy*, 41, pp. 167-178.

Kintsch, W. & Van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological review*, 85, pp. 363-394.

Klein, D.E.., Klein, H.A. & Klein, G. (2000). *Macrocognition: Linking Cognitive Psychology and Cognitive Ergonomics*. In Proceedings of the 5th International Conference on Human Interactions with Complex Systems, University of Illinois at Urbana-Champaign, 2000, pp. 173–177.

Klein, G. A. (1989). Recognition-primed decisions. In W. B. Rouse (Ed), *Advances in man-machine system research*. Greenwich, CT, JAI Press, 5, pp. 47-92.

Klein, G. A. (1995). *Naturalistic Decision Making and Wildland Firefighting*. Paper presented at the U.S. Forest Service Conference, Missoula, Montana, June 12, 1995.

Klein, G. A. (1997). The current status of the naturalistic decision making framework. In R. Flin, E. Salas, M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Themes and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Klein, G. A. (1997a). Naturalistic Decision Making: Where are we going? In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Klein, G. A. (1997b). The Recognition-Primed Decision (RPD Model: Looking Back, Looking Forward. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Klein, G. A. (1998). *Sources of Power: How People Make Decisions*. MIT Press, Second Edition.

Klein, G., Ross, K. G., Moon, B. M., Klein, D. E., Hoffman, R. R., & Hollnagel, E. (2003). Macrocognition. *IEEE Intelligent Systems*, 18(3), pp. 81-85.

Klein, G. A., Calderwood, R. & Clinton-Cirocco, A. (1986). Rapid decision making on the fire ground. *Proceedings of the Human Factors Society, 30th Annual Meeting*, 1, pp. 576-580.

Klein, G. & Hoffman, R. R. (2008). Macrocognition, Mental Models, and Cognitive Task Analysis Methodology. In J. Maarten Shraagen, L. G. Militello, T. Ormerod & R. Lipshitz (Eds). *Naturalistic Decision Making and Macrocognition*, pp. 57-80. Aldershot : Ashgate Publishing Ltd.

Klein, G. A., Orasanu, J., Calderwood, R. & Zsambok, C. E. (1993). *Decision-Making-in-Action: Models and Methods*. Norwood, NJ: Ablex.

Klein, G. S. (1970). *Perception, motives, and personality*. New-York: Alfred A. Knopf.

Kluft, R. P; (1997). The Argument for the Reality of Delayed Recall of Trauma. In P. S. Appelbaum, L. A. Uyehara & M. R. Elin (Eds). *Trauma and Memory. Clinical and legal controverses*. Oxford University Press.

Kosslyn, S. M. (2006). You can play 20 questions with nature and win: Categorical versus coordinate spatial relations as a case study. *Neuropsychologia*, 44, p. 1519–1523.

Koutstaal, W. & Schacter, D. L. (1997). Inaccuracy and Inaccessibility in Memory Retrieval: Contributions from Cognitive Psychology and Neuropsychology. In P. S. Appelbaum, L. A. Uyehara & M. R. Elin (Eds). *Trauma and Memory. Clinical and legal controverses*. Oxford University Press.

Kowalski, K. M. (1995). A human component to consider in your emergency management plans: the Critical Incident stress factor. *Safety Science*, 20, pp. 115-123.

Kris, E. (1956). The recovery of childhood memories in psychoanalysis. Psychoanalitical Study of the Child, 11, pp. 54-88.

Lamareille, V. (2009). La psychanalyse décrite en UML. ISBN : 978-2-9535426-0-8. Retrieved from the Internet on July, 29th 2012 at http://psyuml.wordpress.com/le-livre/lecture-en-ligne

Laplanche, J. & Pontalis, J-B. (2004). *Vocabulaire de la psychanalyse*. Paris : PUF, collection Quadrige (4th edition).

Larivey, M. (2002). *La puissance des émotions. Comment distinguer les vraies des fausses*. Canada : Les Éditions de l'Homme.

Lazarus, R. S. (1993). Coping Theory and Research: Past, Present, and Future. *Psychosomatic Medicine*, 55, pp. 234-247.

Lazarus, R. S. (1993b). From psychological stress to the emotions. A History of Changing Outlooks. Annual Review of Psychology, 44, pp. 1-21

Lazarus, R. S. & Folkman, S. (1984). *Stress, Appraisal, and Coping*. New York: Springer.

Lebigot, F. (2005). *Traiter les traumatismes psychiques*. Dunod.

LeDoux, J. (1996). *The Emotional Brain*. New York: Simon Schuster.

Lewis, M. D. (2000). Emotional Self-Organization at Three Time-Scales. In M. D. Lewis & I. Granic (Eds.). *Emotion, Development, and Self-organization.* Cambridge University Press.Lichtenstein, W. & Slovic, P. (1971). Reversals of preferences between bids and choices in gambling decisions. *Journal of Experimental Psychology*, 89, pp. 46–55.

Lichtenstein, W., Slovic, P. & Zink, D. (1969). Effect of instruction in expected value on optimality of gambling decisions. *Journal of Experimental Psychology*, 79, pp. 236–240.

Lipshitz, R. (1997). Naturalistic Decision Making. Perspectives on Decision Errors. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Lipshitz, R. (1997a). On-line coping with uncertainty: Beyond the reduce, quantify and plug heuristic. In R. Flin, E. Salas, M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Thems and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Lipshitz, R., Klein, G., Orasanu, J. & Salas, E. (2001). Focus Article: Taking Stock of Naturalistic Decision Making. *Journal of Behavioral Decision Making*, 14, pp. 331-352.

Livet, P. (2002). *Emotions et rationalité morale*. Paris: Presses Universitaires de France.

Luthar, S. S., Cicchetti, D. & Becker, B. (2000). The construct of resilience : A Critical Evaluation and Guidelines for Future Works. *Child Development*, 71(3), pp. 543-562.

Lutz, A., Lachaux, J-P., Martinerie, J. & Varela, F. J (2002). Guiding the study of brain dynamics by using firstperson data: Synchrony patterns correlate with ongoing conscious states during a simple visual task. In *PNAS*, 99(3), pp. 1586–1591.

Maarten Schraagen, J., Klein, G. & Hoffman, R. R. (2008). The Macrocognition Framework of Naturalistic Decision Making. In J. Maarten Shraagen, L. G. Militello, T. Ormerod & R. Lipshitz (Eds), pp. 3-26. *Naturalistic Decision Making and Macrocognition*. Aldershot : Ashgate Publishing Ltd.

Maclean, N. (1993). *Young Men and Fire*. Chicago: The Chicago University Press (Paperback edition).

Mandler, J. M. & Johnson, N. S. (1977). Remembrance of things parsed : story, structure and recall. *Cognitive Psychology*, 9, pp. 111-151.

Marbach, E. (1993). *Mental Representation and Consciousness. Towards a Phenomenological Theory of Representation and Reference*. Dordrecht: Kluwer Academic Publishers.

March, J. G. & Olsen, J. P. (1986). Garbage Can Models of Decision Making in Organizations. In K. G. March & R. Weissinger-Baylon (Eds). *Ambiguity and Command*. Longman Inc, USA (1986).

March, J. G. & Simon, H. A. (1958). *Organizations*. NewYork: J.Wiley.

Marmar, C. R., Weiss, D. S., Metzler, T. J. & Delucchi, K. (1996). Characteristics of emergency services personnel related to peritraumatic dissociation during critical incident exposure. *American Journal of Psychiatry*, 153, pp.94-102.

Marmar, C. R., McCaslin, S. E., Metzler, T. J., Best, S., Weiss, D. S., Fagan, J., Liberman, A., Pole, N., Otte, C., Yehuda, R., Mohr, D. & Neylan, T. (2006). Predictors of Posttraumatic Stress in Police and Other First Responders. *Ann. N.Y. Acad. Sci*., 1071, pp. 1–18.

Matthews, J. A. & Chu, J. A. (1997). Psychodynamic Therapy for patients with Early Childhood Trauma. In P. S. Appelbaum, L. A. Uyehara & M. R. Elin (Eds). *Trauma and Memory. Clinical and legal controverses*. Oxford University Press.

Maurel, M. (2008). La psycho-phénoménologie, théorie de l'explicitation. *Expliciter*, 77, pp. 1-29

Mayes, A. R. & Roberts, N. (2001). Theories of episodic memory. In A. Baddeley, M. Conway & J. Aggleton (Eds). *Episodic Memory. New directions for research*. Oxford University Press.

McCabe, V. (1982). The Direct Perception of Universals: A Theory of Knowledge Acquisition. *Synthese*, 52, pp. 495-513.

McGinn, C. (1991). *The Problem of Consciousness*. Blackwell.

McLennan, J., Omodei, M., Holgate, A. & Wearing, A. J. (2003). *Human Information Processing aspects of Effective Emergency Incident Management Decision Making*. Paper presented at the Human Factors of Decision Making in Complex System Conference, Dunblane Scotland, September 2003.

McLennann, J., Holgatenn, A. M., Omodei, M. M. and Wearing, A. J. (2006). Decision Making Effectiveness in Wildfire Incident Management Teams. *Journal Of Contingencies And Crisis Management*, 14(1), March 2006.

McLeod, H. J., Byrne, M. K. & Aitken, R. (2004). Automatism and dissociation: Disturbances of consciousness and volition from a psychological perspective. *International Journal of Law and Psychiatry*, 27, pp. 471-487.

McNally, R. J. (2003). Psychological Mechanisms in Acute Response to Trauma. *Biol Psychiatry*, 53, pp. 779-788.

Memon, A., Wark, L., Bull, R. & Koehnken, G. (1997). Isolating the effects of the Cognitive Interview techniques. *British Journal of Psychology*, 88(2), pp. 179-198.

Mendenhall, W., Beaver, R. J. & Beaver, B. M. (2003). *Introduction to probability and statistics*. Thomson Brooks/Cole.

Meredith, L. S., Sherbourne, C. D., Gaillot, S., Hansell, L., Ritschard, H. V., Parker, A. M. & Wrenn, G. (2011). *Promoting Psychological Resilience in the U.S. Military*. USA, Santa Monica, CA: Rand Corporation.

Metzl, E. S. (2007). *Exploration of Creativity and Resiliency in Survivors of Hurricane Katrina*. PhD thesis, the Florida State University College of Visual Arts, Theatre and Dance. Retrieved from the Internet.

Mitchell, A. M., Sakraida, T. J. & Kameg, K. (2003). Critical Incident Stress Debriefing: Implications for Best Practice. *Disaster Management & Response*, 1(2).

Mitchell, J. (1983). When disaster strikes... The Critical Incident Stress Debriefing process. *Journal of Emergency Medical Services*, 8, pp. 36–39.

Moore-Merrell, L., Zhou, A., McDonald-Valentine, S., Goldstein, R. & Slocum, C. (2008). *Contributing factors to firefighter line-of-duty injury in metropolitan fire departments in the united states*. International Association of Fire Fighters. http://www.iaff.org/08News/PDF/InjuryReport.pdf.

Moshkina, L. (2006). *An Integrative Framework for Affective Agent Behavior*. Paper presented at the IASTED International Conference on Intelligent Systems and Control 2006.

Moshkina, L. & Arkin, R.C. (2003). *On TAMEing Robots*. Proceedings of IEEE International Conference on Systems, Man and Cybernetics, Oct. 2003.

Moshkina, L. & Arkin, R.C. (2005). *Human Perspective on Affective Robotic Behavior: A Longitudinal Study*. Paper presented at IEEE IROS 2005.

Mosier, K. L. & Fischer, U. (2010). The Role of Affect in Naturalistic Decision Making. *Journal of Cognitive Engineering and Decision Making*, 4(3), pp. 240–255.

Moustakas, C. (1994). *Phenomenological Research Methods*. Thousand Oaks: Sage.

Naccache, L. (2006). *Le nouvel inconscient. Freud, Christophe Colomb des neurosciences*. Paris: Odile Jacob.

Naudin, J., Gros-Azorin, C., Mishara, A., Wiggins, O. P., Schwartz, M. A. & Azorin, J-M. (1999). The Use of the Husserlian Reduction as a Method of Investigation in Psychiatry. In F. Varela & J. Shear (Eds), The View from Within. First-person approaches to the study of consciousness, *Journal of Consciousness Studies*, 6(2-3), pp.155-171.

NFPA. (1997). *NFPA 1500 :1997 - Fire department occupational safety and health program*. National Fire Protection Association.

Newell, A. (1973). You can't play 20 questions with nature and win. In W. G. Chase (Ed.), *Visual information processing*. New York: Academic Press.

Norman, D. A. (1988). *The design of everyday things*. New York: Currency-Doubleday.

OMG (2011). *Business Process Model and Notation (BPMN).* Object Management Group (OMG). Retrieved from the Internet on July 29th, 2012 at http://www.omg.org/spec/BPMN/2.0

Omodei, M., Wearing, A. & McLennan, J. (1997). Head-mounted video recording: A methodology for studying naturalistic decision making. In R. Flin, E. Salas, M. Strub & L.

Martin (Eds). *Decision Making Under Stress. Emerging Thems and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Omodei, M., McLennan, J. & Wearing, A. (2002). Head-Mounted Video Cued Recall: A Methodology for Detecting, Understanding, and Minimising Error in the Control of Complex Systems. In C. W. Johnson (Ed.) *Human Decision Making and Control*, Proceedings of the 21st European Conference on Human Decision Making and Control, Scotland : University of Glasgow.

Omodei, M., McLennan, J. & Reynolds, C. (2005). *Identifying Why Even Well-Trained Firefighters Make Unsafe Decisions: A Human Factors Interview Protocol*. Eighth International Wildland Fire Safety Summit, April 26-28, 2005, Missoula, MT.

Orasanu, J. (1997). Stress and naturalistic decision making: Strengthening the weak links. In R. Flin, E. Salas, M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Themes and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Orasanu, J. & Fischer, E. (1997). Finding Decisions in Natural Environments: The View from the Cockpit. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Ortony, A., Clore, G., & Collins, A. (1988). *The Cognitive Structure of Emotions*. Cambridge University Press.

Pascual, R. & Henderson, S. (1997). Evidence of Naturalistic Decision Making in Military Command and Control. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Pennington, N. & Hastie, R. (1986). Evidence Evaluation in Complex Decision Making. *Journal of Personality and Social Psychology*, 51(2), pp. 242-258.

Pennington, N. & Hastie, R. (1988). Explanation-Based Decision Making: Effects of Memory Structure on Judgements. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 14(3), pp. 521-533.

Pennington, N. & Hastie, R. (1992). Explaining the Evidence: Tests of the Story Model for Juror Decision Making. *Journal of Personality and Social Psychology*, 62(2), pp.189-206.

Petimengin, C. (2008). Phénoménologie et techniques neuroscientifiques : Quels enjeux thérapeutiques ou existentiels ? In P-E. Schmit & P-A. Chardel (2008). *Phénoménologie et Technique(s)*, Paris : Collection Phéno, Le Cercle Herméneutique, Série Philosophie Générale.

Popper, K. R. (1988). *The Open Universe. An Argument for Indeterminism*. London: Hutchinson (Paperback edition).

Prat, M. (2006). *Processus cognitifs et émotions*. Paris: L'Harmattan.

Pruitt, J. S., Cannon-Bowers, J. A. & Salas, E. (1997). In search of naturalistic decisions. In R. Flin, E. Salas, M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Thems and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Putnam, T. (1995). The Collapse of Decisionmaking and Organizational Structure on Storm King Mountain. In T. Putnam (1995). *Findings from the wildland firefighters human factors workshop*, 12-16 June 1995, Tech. Rep. 9551-2855-MTDC, Department of Agriculture, Forest Service, Missoula Technology and Development Center, Missoula, MT.

Pynoos, R. S., Steinberg, A. M. & Aronson, L. (1997). Traumatic Experiences: The Early Organization of memory in School-age Children and Adolescents. In P. S. Appelbaum, L. A. Uyehara & M. R. Elin (Eds). *Trauma and Memory. Clinical and legal controverses*. Oxford University Press.

Quinlan, R. (1979). Discovering rules by induction from large collections of examples. In D. Michie, (Ed.), *Expert Systems in the Microelectronic age*, pp. 168-201.

Quinlan, R. (1993). *C4.5: Programs for Machine Learning*. Morgan Kaufman.

Rasmussen, J. (1983). Skills, Rules, and Knowledge; Signals, Signs, and Symbols, and Other Distinctions in Human Performance Models. *IEEE Transactions on Systems, Man, and Cybernetics*, 13(3), pp. 257-266.

Rasmussen, J. (1985). *A framework for cognitive task analysis in systems design*. Invited tutorial presented at NATO Advanced Study Institute on Intelligent Decision Aids in Process Environments, September 1985, Pisa, Italy.

Rasmussen, J. (1997). Merging paradigms: Decision making, management, and cognitive control. In R. Flin, E. Salas), M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Themes and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Regehr, C., Dimitropoulos, G., Bright, E., George, S. & Henderson, J. (2005). Behind the Brotherhood: Rewards and Challenges for Wives of Firefighters. *Family Relations*, 54, pp. 423–435. Blackwell Publishing.

Robinson, J. A. (1995). Perspective, meaning, and remembering. In D. C. Rubin (Ed). *Remembering Our Past. Studies in Autobiographical Memory*. Cambridge University Press.

Rolland, D. (2005). *Sapeurs-Pompiers de Paris. Culture et traditions*. Paris: Atlante Editions.

Rosat, J-J. (2008). L'illusion phénoménologique et la description de l'expérience. In C. Romano (Ed). *Wittgenstein et la tradition phénoménologique*. Paris: Le Cercle Herméneutique, Collection Phéno, Septembre 2008, pp. 11-30.

Ross, B. M. (1991). *Remembering the personal past: Descriptions of autobiographical memory*. New York: Oxford University Press.

Rouger, F. (1969). La phénoménologie. In A. Noiray (Ed.). *La Philosophie*. Paris: Centre d'Etude et de Promotion de la Lecture.

Rousseau-Dujardin, J. (1998). Trauma. In P. Kaufmann (Ed.), *L'Apport freudien. Éléments pour une encyclopédie de la psychanalyse*, Paris, Larousse-Bordas, pp. 606-607.

Rutter, M. (1998). L'Enfant et la résilience. *Le Journal des Psychologues*, 162, pp. 46-49.

Ryle, G. (1949). *The concept of mind*. Harmondsworth, UK: Penguin.

Sauzier, M. C. (1997). Memories of Trauma in the Treatment of Children. In P. S. Appelbaum, L. A. Uyehara & M. R. Elin (Eds). *Trauma and Memory. Clinical and legal controverses*. Oxford University Press.

Schacter, D. L. & Dodson, C. S. (2001). Misattribution, false recognition and the sins of memory. In A. Baddeley, M. Conway & J. Aggleton (Eds). *Episodic Memory. New directions for research*. Oxford University Press.

Schönpflug, W. (1983). Coping Efficiency and Situational Demands. In G. R. J. Hockey (Ed). *Stress and Fatigue in Human Performance*. John Wiley & Sons.

Schraw, G. & Dennison, R. S. (1994). Assessing Metacognitive Awareness. *Contemporary Educational Psychology*, 19, pp. 460-475.

Schraw, G. & Moshman, D. (1995). Metacognitive Theories. *Educational Psychology Review*, 7(4), pp. 351-371.

Schutz, A. (1987). *Le chercheur et le quotidien. Paris* : Méridiens Klincksieck. (French translation of Schutz, A. (1945). On multiple realities. In *Philosophy and Phenomenological Research*, 5(4), pp. 553-576.

Searle, J. R. (1985). *L'intentionnalité. Essai de philosophie des états mentaux*. Paris: Les Editions de Minuit. (French translation of Searle, J. R. (1983). *Intentionality. An essay in the philosophy of mind*. Cambridge University Press.

Serfaty, D. & Entin, E. E. (1997). Team adaptation and co-ordination training. In R. Flin, E. Salas, M. Strub & L. Martin (Eds). *Decision Making Under Stress. Emerging Themes and Applications*. Aldershot: Ashgate, 2007 Paperback Edition.

Shaughnessy, J. J., Zechmeister, E. B. & Zechmeister, J. S. (2006). *Research Methods in Psychology*. McGraw Hill Higher Education.

Silverman, D. (2006). *Qualitative Research. Theory, Method and Practice*. Sage Publications (2nd Edition, first printed 2004).

Simon, H. A. (1947). *Administrative behaviour: a study of Decision Making Processes in Administrative Organizations*. Mac Millan,NewYork.

Simon, H. A. (1954). A behavioral model of rational choice. *Quarterly Journal of economics*, 69, pp. 99–118.

Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review*, 63, pp. 129–138.

Simon, H. A. (1957). A behavioural model of rational choice. In H. A. Simon (Ed). *Models of man: social and rational; mathematical essays on rational human behavior in a social setting*. NewYork: J.Wiley.

Skinner, B. F. (1985). Cognitive science and behaviorism. *British Journal of Psychology*, 76, pp. 291–301.

Skinner, E. A. & Zimmer-Gembeck, M. J. (2007). The Development of Coping. *Annual Review of Psychology*, 58, pp. 6.1-6.26.

Slovic, P. & Lichtenstein, W. (1968). The relative importance of probabilities and payoffs in risk taking. *Journal of Experimental Psychology Monographs*, 78, pp. 1–18.

Slovic, P., Finucane, M., Peters, E. and MacGregor, D. G. (2002). The affect heuristic. In T. Gilovich, D. Grifin and D. Kahneman (Eds). *Heuristics and Biases: The Psychology of Intuitive Judgement*. Cambridge, England: Cambridge University Press, pp. 397–420.

Slovic, P., Finucane, M., Peters, E. and MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. Risk Analysis, 24, pp. 311–321.

Spear-Ellinwood, K. C. (2008). *The Making of a Metacognitive Mind: What is metacognition? What does it look like in real life? And, how can we provoke it? A working paper on Metacognition for the UA Science Center Exhibition Task Force*. University of Arizona Board of Regents.

Spinelli, E. (1989). *The Interpreted World. An Introduction to Phenomenological Psychology*. London: Sage Publications.

Stanghellini, G. (2004). The Puzzle of the Psychiatric Interview. *Journal of Phenomenological Psychology*, 35(2).

Stern, D. N. (2004). *The Present Moment in psychotherapy and everyday life*. New York: Norton.

Stokes, A. F. & Kite, K. (1994). *Flight Stress: Stress, Fatigue, and Performance in Aviation*. Brookfield, VT: Ashgate.

Stokes, A. F., Kemper, K. & Kite, K. (1997). Aeronautical Decision Making, Cue Recognition, and Expertise Under Time Pressure. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Styles, E. A. (1997). *The psychology of attention*. Psychology Press.

Sun, R., Zhang, X. & Mathews, R. (2006). Modeling meta-cognition in a cognitive architecture. *Cognitive Systems Research*, 7, pp.327–338.

Sweeney, P. (2012). *Grieving Behind the Badge. Improving the lives of emergency response professionals*. Retrieved from the internet on July 21st, 2013 at http://sweeneyalliance.org/grievingbehindthebadge/firefighters-at-risk/.

Tardieu, H., Rochfeld, A., & Colletti, R. (1983). *La méthode Merise : Principes et outils*. Paris : Éditions d'organisation.

Tardieu, H., Rochfeld, A., & Colletti, R., Panet, G., & Vahéee, G. (1985). *La méthode Merise : Démarches et pratiques*. Paris : Éditions d'organisation.

Tharp, R. G. & Gallimore, R. (1985). The Logical Status of Metacognitive Training. *Journal of Abnormal Child Psychology*, 13(3), pp. 455-466.

Théron, P. (2005). *Dynamique de l'émergence des accidents dans les systèmes socio-techniques. Etude de la réaction humaine de transformation de la situation. Propositions théoriques et épistémologiques. Application à la sécurité ferroviaire*. Msc Thesis, Paris X / Ecole Nationale Supérieure des Mines de Paris – Ecole Polytechnique. Unpublished.

Théron, P. (2008). The Process of Individual Resilience: A Pheno-Cognitive Study of a Fire Fighter's Response to Surprise. *HFES: Cognitia*, 12(1), pp. 4-7.

Theron, P. (2009). Lieutenant A and the rottweilers: a Pheno-Cognitive Analysis of Firemen's resilience in action. *International Journal of Emergency Management*, 6(2), pp.179–207.

Théron, P. (2013). ICT Resilience as Dynamic Process and Cumulative Aptitude. In P. Théron & S. Bologna (Eds.) *Critical Information Infrastructure Protection and Resilience in the ICT Sector*, pp. 1-35. IGI Global.

Theureau, J. (2004). *Le cours d'action. Méthode élémentaire*. Toulouse : Octares.

Thinès, G. (1977). *Phenomenology and the Science of Behaviour. An Historical and Epistemological Approach*. London: George Allen & Unwin.

Thompson, E. (2007). *Mind in Life. Biology, Phenomenology and the Sciences of Mind*. Harvard University Press.

Titus, C. S. (2002). *Resilience and Christian virtues. What the Psychosocial Sciences Offer for the renewal of Thomas Aquinas' Moral Theology of Fortitude and Its Related Virtues*. PhD Thesis, Faculty of Theology at the University of Fribourg. Retrieved from the Internet.

Tuckey, N. R. (2007). Issues in the Debriefing Debate for the Emergency Services: Moving Research Outcomes Forward. *Clinical Psychology: Science and Practice*, 14(2), pp. 106-116.

Tulving, E. (1983). *Elements of episodic memory*. New-York: Oxford University Press.

Tulving, E. (2001). Episodic memory and common sense: how far apart? In A. Baddeley, M. Conway & J. Aggleton (Eds). *Episodic Memory. New directions for research*. Oxford University Press.

Tversky, A. (1967). Additivity, utility and subjective probability. *Journal of Mathematical Psychology*, 4, pp. 175–201.

Tversky, A. (1969). Intransitivity of preferences. *Psychological Review*, 76, pp. 31–48.

Tversky, A. (1972). Elimination by aspects: A theory of choice. *Psychological Review*, 79, pp. 281–299.

Tversky, A. & Kahneman, D. (1974). Judgement under uncertainty: heuristics and biases. *Science*, 185, pp. 1124-1131.

Upton, G. & Cook, I. (2006). *Oxford Dictionary of Statistics, 2nd Edition*. Oxford University Press.

Van der Kolk, B. A. (1997). Traumatic Memories. In P. S. Appelbaum, L. A. Uyehara & M. R. Elin (Eds). *Trauma and Memory. Clinical and legal controverses*. Oxford University Press.

Varela, F. J. (1999). Present-Time Consciousness. *Journal of Consciousness Studies*, 6(2-3), pp. 111-140.

Varela, F. J. & Shear, J. (1999). First-Person Methodologies: What, Why, How? In F. J. Varela & J. Shear, The View from Within. First-person approaches to the study of consciousness. *Journal of Consciousness Studies*, 6(2-3), pp. 1-14.

Varela, F. J. & Shear, J. (1999a). Editors' rejoinder to the debate. In F. J. Varela & J. Shear, The View from Within. First-person approaches to the study of consciousness. *Journal of Consciousness Studies*, 6(2-3), pp. 307-311.

Vermersch, P. (1999). Phénoménologie de l'attention selon Husserl : 2/ La dynamique de l'éveil. *Expliciter*, 29, pp. 7-20.

Vermersch, P. (2006). *L'entretien d'explicitation*. Paris: ESF Editeurs.

Vogeley, K. & Fink, G. R. (2003). Neural correlates of the first-person-perspective. *Trends in Cognitive Science*, 7(1), pp. 38–42.

Von Neumann, J. & Morgenstern, O. (1944). *Theory of games and economic behavior*. Princeton University Press.

Vrignaud, C. (2008). La mauvaise rencontre ou le face à face avec l'impensable: clinique de la violence intentionnelle. *Journal International de Victimologie*, 6(2), pp. 145-150.

Waag, W. L. & Bell, H. H. (1997). Situation Assessment and Decision Making in Skilled Fighter Pilots. In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Wang, Y. (2009). A Cognitive Informatics Reference Model of Autonomous Agent Systems (AAS). In *International Journal of Cognitive Informatics and Natural Intelligence*, 3(1), pp. 1-16.

Watson, C. (2006). Unreliable narrators? 'Inconsistency' (and some inconstancy) in interviews. *Qualitative Research*, 6(3), pp. 367–384.

Watzlawick, P., Beavin, J. H. & Jackson, D. D. (1967). *Pragmatics of Human Communication*. NewYork : Norton.

Webb, G. (1997). Deconstructing Deep and Surface: Towards a Critique of Phenomenography. *Higher Education*, 33(2), pp. 195-212.

Weick, K. (1993). The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster. *Administrative Science Quarterly*, 38(4).

Weick, K. (1995). *Sensemaking in Organizations*. Thousand Oaks: Sage.

Wells, A. & Sembi, S. (2004). Metacognitive therapy for PTSD: a preliminary investigation of a new brief treatment. *Journal of Behavior Therapy and Experimental Psychiatry*, 35, pp. 307-318.

Willig, C. (2008). *Introducing Qualitative Research in Psychology*. Mac Graw Hill, Open University Press.

Wolf, L. D., Potter, P., Sledge, J. A., Boxerman, S. B., Grayson, D. & Evanoff, B. (2006). Describing Nurses' Work: Combining Quantitative and Qualitative Analysis. *Human Factors*, 48(1), pp. 5-14.

Woods, D. D. (1993). Process-tracing methods for the study of cognition outside of the experimental psychology laboratory. In G. A. Klein, J. Orasanu, R. Calderwood & C. E. Zsambok (Eds.) *Decision-Making-in-Action: Models and Methods*. Norwood, NJ: Ablex.

Yakovleff, M. (2006). *Tactique théorique*. Paris: Economica, Collection Stratégies & Doctrines.

Zachary, W. W., Ryder, J. M. & Hicinbothom, J. H. (1998). Cognitive task analysis and modeling of decision making in complex environments. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making Decisions Under Stress. Implications for Individual and Team Training.*, pp. 315-344. Washington: American Psychological Association.

Zachary, W., Campbell, G. E., Laughery, K. R., Glenn, F. & Cannon-Bowers, J. A. (2001). The application of human modeling technology to the design, evaluation and operation of complex systems. *Advances in Human Performance and Cognitive Engineering Research*, 1, pp. 199–247.

Zadeh, L. A. (1965). Fuzzy sets. *Information Control*, 8, pp. 338–353.

Zadeh, L. A. (1978). Fuzzy sets as a basis for theory of possibility. *Fuzzy Sets and Systems*, 1, pp. 3–28.

Zajonc, R. B. (1965). Social facilitation. *Science*, 1429, pp. 269-274.

Zimmer, H. (2001). Why do Actions Speak Louder than Words? Action Memory as a Variant of Encoding Manipulations or a Specific Memory System? In H. D. Zimmer, R. L.

Cohen, M. J. Guynn, J. Engelkamp, R. Kormi-Nouri & M. A. Foley (Eds). *Memory for Action. A Distinct Form of Episodic Memory?* Counterpoints. Cognition, Memory & Language. Oxford University Press.

Zimmer, H. D. & Cohen, R. L. (2001). Remembering Actions. A Specific Type of memory ? In H. D. Zimmer, R. L. Cohen, M. J. Guynn, J. Engelkamp, R. Kormi-Nouri & M. A. Foley (Eds). *Memory for Action. A Distinct Form of Episodic Memory?* Counterpoints. Cognition, Memory & Language. Oxford University Press.

Zsambok, C. E. (1997). Naturalistic Decision Making: Where Are We Now? In C. E. Zsambok & G. A. Klein (Eds). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

Zsambok, C. E. & Klein, G. A., Eds (1997). *Naturalistic Decision Making*. Mahwah, New Jersey. Lawrence Erlbaum Associates.

CHAPTER 17. Thematic index

A

B

C

D

E

F

I

J

M

N

P

S

T

End notes

[1] John-Steiner, V. (1985). *Notebooks of the mind*. University of New Mexico Press. Albuquerque:NM.

[2] Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning Work. *Ergonomics*, 43(7), pp. 960-974.

[3] at http://www.iafc.org

[4] at http://www.firefighternearmiss.com

[5] at http://www.iafc.org

[6] They add that "*The U.S. Fire Administration's (USFA) voluntary-enrollment National Fire Incident Reporting System (NFIRS) comprises the largest information database used for analysis in most academic and government publications on firefighter injuries and fatalities*." (ibid, p. 5).

[7] Fire Brigades Union (UK)

[8] "*Although statistics on the number of attacks on firefighters collected by individual brigades, and anecdotal evidence from firefighters themselves, suggests that the problem is both extremely serious and on the increase, it is only very recently that data has been collected and published at national level across the UK in an attempt to quantify the scale of the problem. For England and Wales, the Office of the Deputy Prime Minister (ODPM) has collected figures since 1 April 2004 at the request of the Chief Fire Officers Association (CFOA) Operations Committee. Its statistics show that there were almost 400 attacks on firefighters over the nine-month period to the end of January 2005 (see table 1). The ODPM confirmed that the statistics are to be collected on an ongoing basis. However, this figure is based on serious underreporting by brigades – only 18 out of the 50 English and Welsh fire and rescue services responded to requests for information in compiling these figures, representing only around a third (36%) of all brigades in England and Wales*." (p. 3).

[9] "*In March this year a two year old boy died in the Easterhouse area of Glasgow after he was shot in the head with an air rifle while walking down the street with his older brother. Police believe that he was shot accidentally – the real target being firefighters attempting to put out a kitchen fire. A firefighter was also hit with an airgun pellet at around the same time. […] Attacks on firefighters are both widespread and increasing. In February, a firefighter was shot at with an air rifle by a group of youths as he tackled a blaze and attempted to rescue people trapped in a three storey building in Stockwell, south London. On one night at the beginning of March this year, Belfast fire crews faced eight separate hostile incidents over a 10-hour period. And at the end of March two firefighters and a sub-officer were injured when their crew faced a*

barrage of missiles – sticks, stones and bottles – while attending a small rubbish .re in Winton, Eccles in Lancashire. In December, a firefighter in Stockton, Cleveland needed hospital treatment after being punched in the face and knocked unconscious by youths attempting to steal a defibrillator and first aid kit from his engine. And these are just the incidents that get reported in the press. In some areas, attacks involving air rifles, crossbows, missiles including bricks, stones and bottles or verbal abuse happen virtually every night. In Strathclyde, where the young boy was killed, firefighters say that the problem is escalating, with more frequent attacks and more serious incidents occurring. In Central Command alone over a three month period to the end of 2004, there had been 26 incidents involving groups of youths throwing stones, bottles, fireworks or other objects at crews and appliances." (p. 1).

[10] "*Although the problem tends to be worse in deprived areas, it is by no means only firefighters working in poor inner city areas that are being attacked. Two of the 26 attacks on firefighters recorded by the Kent Fire and Rescue Service over a 12 month period in 2003/4, for example, occurred in Tunbridge Wells. In South Wales, although some areas of Cardiff are problem areas, so are villages and small towns like Abersychan, Tredegar, Merthyr Tydfil and Aberdare. And Eddie Cardoso, FBU Brigade Secretary in Berkshire recently told Firefighter magazine, 'People… think of Berkshire as Windsor Castle, Eton School and Royal Ascot. But like most other brigades we have areas which are either trouble spots or potential trouble spots. This isn't just about inner cities.'*" (p. 3).

[11] "*In Scotland also, official figures do not reflect the extent of the problem. The Scottish Executive (SE) has collated figures from Scottish Brigades since April 2003. It reported at the end of 2004 that there were 388 attacks on fire service personnel – more than one a day – between April 2003 and March 2004*." (p. 3).

[12] Beignon (2003) reporting an increase in the number of cases of violence underlines the necessity for firemen to continue to perform their duties as always : "*Il en va de même pour le pompiers qui, en dépit des phénomènes d'insécurité éprouvés sur le terrain, doivent continuer à exercer leur mission*" (p. 15).

[13] The 2008 Annual Report of the French Observatoire de la Délinquance (http://www.cartocrime.net/Cartocrime2/index.jsf) states that in 2008 899 Firemen were victim of an assault, equating to an average national rate of 2 assaults per 10000 interventions. More specifically, the BSPP's average rate was above the national figure at 11.5 per 10000 interventions.

[14] "*really serious incidents are thankfully relatively rare in Scotland, but the cumulative effect of less serious incidents also has an impact on firefighters*." (p. 8).

[15] "*'Stress is a major problem in volunteer fire departments and it's a big reason for attrition' (Streng, 1985, p.24)"*.

[16] Dangerous dogs are a regular problem. In the UK, during the 2013 session of the Commons, the discussion of a Dangerous Dogs Bill was started and the House of Commons (2013) report states that dangerous "*[…]*

dogs are out of control due to the irresponsible or deliberate actions of a minority of owners. Seven people, including five children, have been killed by dogs in homes since 2007 and the cost to the NHS of treating severe dog attack injuries is over £3 million annually. Additionally, many animals, including livestock and some eight assistance dogs a month, are attacked by dogs." (p. 3). The Bill is intended to allow law suits when such events take place in private areas. Details can be found at http://www.parliament.uk/business/committees/committees-a-z/commons-select/environment-food-and-rural-affairs-committee/inquiries/parliament-2010/dangerous-dogs-measures.

[17] For instance at http://www.ukandspain.com/dangerous-dogs/.

[18] http://www.dogsbite.org/dog-bite-statistics-fatalities-2011.php

[19] The Paris Fire Brigade (BSPP : Brigade des Sapeurs-Pompiers de Paris, France) enrolls more than 8000 men in 2007. Further information can be found in end notes and on the BSPP's web site at http://www.pompiersparis.fr.

[20] The French National Day, usually an occasion to pull fireworks

[21] "*Dans son ouvrage, Le ressort invisible. Vivre l'extrême, G. N. Fischer définit ce qu'il entend par vivre l'extrême. Il retient principalement trois caractéristiques: la violence et l'intensité de l'événement vécu, son caractère soudain et imprévu, et l'impossibilité pour le sujet de négocier cet événement par ses moyens habituels*.".

[22] "*sudden losses of meaning which have been variously described as fundamental surprises (Reason, 1990) or events that are inconceivable (Lanir, 1989), hidden (Westrum, 1982), or incomprehensible (Perrow, 1984)*".

[23] My own translation

[24] CISD is not a psychotherapy but rather helps emotionally healthy people to make sense of their adverse experience.

[25] In 2006, these interview reports were found on the Web but are now impossible to retrieve. These testimonies were provided during an internal inquiry performed in October 2001.

[26] The authors summarise its definition by Freud : "*Originally a medical notion, derived from the fields of military medicine and surgery, trauma was subsequently integrated into the field of psychiatry, rather earlier than the notion of stress. […] In 1920, he metaphorically defined trauma as the breaching of the 'protective shield' by an external stimulus, its overwhelming affects pushing the individual into a state of helplessness*.".

[27] For Sauzier (1997) "*There seems to be a contradiction between trauma, which is seen as exceptional, and its consequences, posttraumatic stress symptomatology, which are seen as widespread*." (p. 386), and he adds that "*the definition of trauma itself is still broad, vague, and changeable. Classically, trauma was seen as an extraordinary event that overwhelms the organism's capacity to survive with physical and/or psychological integrity*[27]*. DSM-I related war experiences to 'gross stress reactions'. DSM-III and DSM-IIIR described an event 'outside the range of usual human experience'. DSM-IV has omitted the notion of extraordinariness and describes the event by its consequencesonly (loss of or threat to physical integrity or death).*" (ibid).

[28] "*As noted at the beginning of this paper, "Experiencing trauma is an essential part of being human" (van der Kolk & McFarlane, 1996, p. 3). But what is trauma? Defining "trauma" is a difficult and complex undertaking and has been the subject of much discussion and debate. […] In the Diagnostic and Statistical Manual of Mental Disorders , third editon, revised (DSM-III-R ; American Psychiatric Association, 1987), trauma was defined as something "outside the range of usual human experience" that should "evoke significant levels of distress in most people" (p. 250). However, this definition was deemed by many as unsatisfactory, resulting in critical discussions and suggestions for change (Davidson & Foa, 1991; Kilpatrick & Resnick, 1993; March, 1993). The phrase, "outside the range of usual human experience," came under particular scrutiny. "Traumatic events are extraordinary, not because they occur rarely, but rather because they overwhelm the ordinary human adaptations to life" (Herman, 1997, p. 33). The conceptualization of trauma was changed somewhat in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV ; American Psychiatric Association, 1994). Trauma became defined as when a person "experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others," and "the person's response involved intense fear, helplessness, or horror" (pp. 427–428). This definition is more closely aligned with ideas put forth by a variety of researchers and theorists (e.g., Classen, Koopman, & Spiegel, 1993; Herman, 1997; Kilpatrick & Resnick, 1993; March, 1993; Spiegel & Cardena, 1991) because it is more detailed in operation, more inclusive in experience, and less constrained by the notion of uncommonness. Note also that the definition put forth in the DSM-IV includes the individual's reaction to the event. A traumatic event is a highly subjective experience. Two people may experience the same event, but for one it may be deemed traumatic while for the other it may not. Thus, such an inclusion in the conceptualization of trauma allows the person's subjective experience to be taken into account and potentially allows certain events to be labeled as traumatic even if they are not distressing to most other people*."

[29] in Freud's *Jenseits des Lustprinzips*, Beyond the principle of pleasure, 1920

[30] "*a lived experience that brings, within a short lapse of time, such a high rise in psychological excitation that its liquidation or elaboration through ordinary and usual means fails, which can but entail long lasting disorders in the energetic functioning*"

[31] My own translation

[32] Clervoy (2007, pp. 28-29), refering to the French psychoanalyst Jacques Lacan[32], distinguishes (possibly stressful) expected events ("*automaton*") from traumatic events conceived as unexpected, surprising, events ("*tuché*").

[33] A French Army's chief psychiatrist

[34] A French Army's chief psychiatrist also

[35] "*Fright is depicted by subjects in terms of 'a halt', 'a blank', of an eclipse of the Self – 'I was not there anymore', of a complete silence, of 'a loss of words', of moments of 'blackout', a 'halt of consciousness' of a very short duration with a loss of emotional feelings* ". My own translation of : "*L'effroi est dit par les sujets en termes de « panne », de « blanc », d'éclipse de soi - « je n'étais plus là », de complet silence, de « perte des mots », de « moment de black-out », un « arrêt de la pensée » d'une durée très brève avec une absence d'émotion*"

[36] "*la rencontre brusque d'un détail insoutenable qui fait irruption dans le champ de vision, se surajoutant à l'horreur préexistante, détail dont l'horreur dépasse en intensité ce que le sujet avait essayé d'anticiper*"

[37] My own translation of : " *Cette incrustation d'une image de la mort va se faire dans trois types de circonstances : 1. C'est la vie du sujet lui-même qui est menacée […] 2. Le réel de la mort est perçu à travers la mort de l'autre […] dans des circonstances où l'effet de surprise joue son rôle […] 3. Chez des personnes impliquées dans la mort de l'autre, préparées à la mort de l'autre, puisqu'elles en sont les auteurs (bourreau par exemple)*"

[38] My own translation

[39] Kowalski's (1995) wording shows the ambiguity surrounding the word Stress that may easily get confused with Trauma : "*Stress may be further categorized as either cumulative stress (eroding, i.e., the daily hassles) or traumatic stress (sudden, intense). In emergency management the focus is on the consequences of traumatic stress.*".

[40] Welford A T (1973) *Stress and Performance*. Ergonomics, 16, 567-580

[41] "*the concept of emotion includes that of stress, and both are subject to appraisal and coping theory. As a topic, stress is more limited in scope and depth than the emotions,*"

[42] "*The term stress, meaning hardship or adversity, can be found - though without a programmatic focus - at least as early as the 14th century (Lumsden 1981). […] Despite […] different usages, however, certain essential meanings are always involved. Whatever words are used to describe the stress process, four concepts must always be considered: **1**. a causal external or internal agent, which Hooke called a load and*

*others call stress or **a stressor**. In my own analyses, I emphasize the person-environment relationship and relational meaning (defined below); **2**. **an evaluation** (by a mind or a physiological system) that distinguishes what is threatening or noxious from what is benign; **3**. **coping processes** used by the mind (or body) to deal with stressful demands; and **4**. a complex pattern of **effects on mind and body**, often referred to as the stress reaction*.". (words put in bold by me)

[43] "*stress consists of three processes. Primary appraisal is the process of perceiving a threat to oneself. Secondary appraisal is the process of bringing to mind a potential response to the threat. Coping is the process of executing that response. Although these processes are most easily described as a linear sequence, Lazarus has emphasized that they do not occur in an unbroken stream. Rather, an outcome of one process may reinvoke a preceding process. For instance, realizing that an adequate coping response is readily available may cause you to reappraise a threat as less threatening. As another example, if a coping response is less effective than expected, you may reappraise the level of threat or reappraise what coping response is appropriate. The entire set of processes, then, may cycle repeatedly in a stressful transaction*.".

[44] "*I recently proposed (74, 75) that psychological stress is best regarded as a subset of emotion. In fact, anger, anxiety, guilt, shame, sadness, envy, jealousy, and disgust, which arise out of conflict, are commonly referred to as the stress emotions. The emotions are a much richer source of information about how people are faring in adaptational encounters, and in their lives overall, than the unidimensional concept of stress. […] This is because stress theory usually provides only two analytic categories with which to consider psychodynamics, high and low; and even if we take into account the distinctions I have made (29) between harm, threat, and challenge, there are still only three categories for analysis of coping psychodynamics. On the other hand, there are 15 or so emotions, each with its own script or story line, its own relational theme, which provides a far richer potential for understanding people and their situations. We learn different things from each emotion about **a person's transaction with the environment**, the environment itself and—if we have information about numerous emotional encounters—about the kind of person we are dealing with. I am, in effect, suggesting that emotions always be measured in the context of research on coping and the psychological stresses that require it*."

"*each emotion arises from a different plot or story about relationships between a person and the environment*" : Lazarus (1993b) identifies "*15 different emotions, more or less (Lazarus 1991b,c). There are roughly 9 so-called negative emotions: anger, fright, anxiety, guilt, shame, sadness, envy, jealousy, and disgust, each a product of a different set of troubled conditions of living, and each involving different harms or threats. And there are roughly 4 positive emotions: happiness, pride, relief, and love. To this list we probably could add three more whose valence is equivocal or mixed: hope, compassion, and gratitude. (Below I suggest the "core" relational themes for each of these emotions).*":

Emotion	Core relational theme
Anger	a demeaning offense against me and mine
Anxiety	facing uncertain, existential threat
Fright	an immediate, concrete, and overwhelming physical danger

Guilt	having transgressed a moral imperative
Shame	failing to live up to an ego-ideaa
Sadness	having experienced an irrevocable loss
Envy	wanting what someone else has
Jealousy	resenting a third party for the loss of, or a threat to, another's affection or favor
Disgust	taking in or being too close to an indigestible object or (metaphorically speaking) idea
Happiness	making reasonable progress toward the realization of a goal
Pride	enhancement of one's ego-identity by taking credit for a valued object or achievement, either one's own or that of someone or group with whom one identifies
Relief	a distressing goal-incongruent condition that has changed for the better or gone away
Hope	fearing the worst but wanting better
Love	desiring or participating in affection, usually but not necessarily reciprocated
Compassion	being moved by another's suffering and wanting to help

[45] Lazarus (1993b) highlights the cognitive nature of the *appraisal* process and of the subject's reaction to a stressor "*psychological stress is dependent on cognitive mediation […] This view is centered on the concept of appraisal, which is the process that mediates - I would prefer to say actively negotiates - between, on the one hand, the demands, constraints, and resources of the environment and, on the other, the goal hierarchy and personal beliefs of the individual*.".

[46] "*the degree of stress reaction depended on evaluative thoughts (appraisal and coping).*".

[47] "*appraisal and coping processes [shape] the stress reaction, and […] these processes, in turn, [are] influenced by variables in the environment and within the person*.".

[48] "*Because psychological stress defines an unfavorable person-environment relationship, its essence is process and change rather than structure or stasis. […] I shifted from an emphasis on ego defenses to a general concept of* ***appraisal*** *as the cognitive mediator of stress reactions. I began to view appraisal as a universal process in which people (and other animals) constantly evaluate the significance of what happening for their personal well-being. In effect, I considered psychological stress to be a reaction to personal harms and threats of various kinds that emerged out of the person-environment relationship.*".

[49] "*I said above, without explanation, that emotions are always a response to relational meaning. The relational meaning of an encounter is a person's sense of the harms and benefits in a particular person-environment relationship. To speak of harms and benefits is to allude to motivational as well as cognitive processes; hence the complex name of the theory, which includes the terms cognitive, motivational, and relational*.".

[50] Selye H (1974) *Stress without Distress*. Philadelphia: Lippincott

[51] "*Personality variables and those that characterize the environment come together in the appraisal of relational meaning. An emotion is aroused not just by an environmental demand, constraint, or resource but*

by their juxtaposition with a person's motives and beliefs. The process of appraisal negotiates between and integrates these two sets of variables by indicating the significance of what is happening for a person's well-being. This is an extension of the cognitive mediational principle in psychological stress theory - namely, that what causes the stress reaction is not the environmental "stressor" alone but also its significance as appraised by the person who encounters it. […] one key appraisal component is motivational; to have an emotion requires an active goal in an encounter; if no goal is at stake there can be no emotion.".

[52] "*Coping depends on appraisal of whether anything can be done to change the situation. If appraisal says something can be done, problem-focused coping predominates; if appraisal says nothing can be done, emotion-focused coping predominates. Here we have rediscovered the Alcoholics Anomymous epigram, that people should try to change the noxious things that can be changed, accept those that cannot, and have the wisdom to know the difference*.".

[53] "*(Lazarus 1966, 1981; Lazarus & Folkman 1984; Lazarus & Launier 1978) emphasized coping as process--a person's ongoing efforts in thought and action to manage specific demands appraised as taxing or overwhelming*.".

[54] "*coping is highly contextual, since to be effective it must change over time and across different stressful conditions (e.g. Folkman & Lazarus 1985).*".

[55] Lazarus (1993b) defines a "*style*" as "*stable properties of personality*". Carver et al. (1989) define a "*coping style*" as a dispositional preference : "'*dispositions' that people bring with them to the stressful situations that they encounter. According to this view, people do not approach each coping context anew, but rather bring to bear a preferred set of coping strategies that remains relatively fixed across time and circumstances.*", and they oppose style and *ad hoc* process : "*Investigating questions pertaining to dispositionally preferred coping styles requires that one be able to measure coping dispositions as well as situational coping responses. Operationally, this is not difficult (cf. the state-trait strategy used by Spielberger, Gorsuch, & Lushene, 1970). When differentiating coping dispositions from situational coping responses, the content of the behavior that is described in the items remains the same; only the frame of reference is altered. When assessing a dispositional coping style, the items are framed in terms of what the person usually does when under stress. When assessing situational responses, the items are framed in terms of what the person did (or is doing currently) in a specific coping episode or during a specific period of time*". Carver et al. (1989) mention "*a pair of coping styles. These styles, termed monitoring versus blunting (Miller, 1987), are different from the strategies we have been discussing. Monitoring is seeking out information about one's situation and its potential impact. Blunting is dealing with an impending stressor by attempting to distract oneself from it (Miller, 1987).*". This notion does not play a central role in Lazarus' theoretical approach anyway as, in fact, he denies the idea that appraisal, just like coping, would be governed by a given style. On the contrary, he says, followed in this by Carver et al. (1989), that appraisal and coping are processes that adjust to circumstances rather than being set, frozen in a given style dependent upon the subject'' personality : "*coping is highly contextual, since to be effective it must change over time and across*

different stressful conditions (e.g. Folkman & Lazarus 1985)." (Lazarus 1993b). Carver et al. (1989) say that "*the development of a coping style would at best be counterproductive, because it locks the person into one mode of responding rather than allowing the person the freedom and flexibility to change responses with changing circumstances.*" and add that "*traditional personality dispositions are not likely to be useful as predictors of coping (e.g., Folkman & Lazarus, 1980).*".

[56] "*Although stable coping styles do exist and are important, […] Empirical evaluation idea requires study of the same persons over time and across diverse stressful encounters*.".

[57] "*Coping affects subsequent stress reactions in two main ways: First, if a person's relationship with the environment is changed by coping actions the conditions of psychological stress may also be changed for the better. My colleagues and I called this problem-focused coping. If we persuade our neighbor to prevent his tree from dropping leaves on our grass, we overcome the original basis of whatever harm or threat their dropping caused us. Other coping processes, which we called emotion-focused coping, change only the way we attend to or interpret what is happening. A threat that we successfully avoid thinking about, even if only temporarily, doesn't bother us*."

[58] "*Coping is complex, and people use most of the basic coping strategies (factors) in every stressful encounter. (Are specific coping strategies tied to specific stress contents, or does one strategy follow another in a sort of trial-and-error process? The answer is likely both.)*".

[59] "*problem-focused coping tends to predominate when people feel that something constructive can be done, whereas emotion-focused coping tends to predominate when people feel that the stressor is something that must be endured (Folkman & Lazarus, 1980).*".

[60] Ways of coping (Carver et al., 1989) are:

Active coping
I take additional action to try to get rid of the problem.
I concentrate my efforts on doing something about it.
I do what has to be done, one step at a time.
I take direct action to get around the problem.
Planning
I try to come up with a strategy about what to do.
I make a plan of action.
I think hard about what steps to take.
I think about how I might best handle the problem.
Suppression of competing activities
I put aside other activities in order to concentrate on this.
I focus on dealing with this problem, and if necessary let other things slide a little.
I keep myself from getting distracted by other thoughts or activities.
I try hard to prevent other things from interfering with my efforts at dealing with this.
Restraint coping
I force myself to wait for the right time to do something.
I hold offdoing anything about it until the situation permits.

I make sure not to make matters worse by acting too soon.
I restrain myself from doing anything too quickly.
Seeking social support for instrumental reasons
I ask people who have had similar experiences what they did.
I try to get advice from someone about what to do.
I talk to someone to find out more about the situation.
I talk to someone who could do something concrete about the problem.
Seeking social support for emotional reasons
I talk to someone about how I feel.
I try to get emotional support from friends or relatives.
I discuss my feelings with someone.
I get sympathy and understanding from someone.
Positive reinterpretation & growth
I look for something good in what is happening.
I try to see it in a different light, to make it seem more positive.
I learn something from the experience.
I learn something from the experience.
I try to grow as a person as a result of the experience.
Acceptance
I learn to live with it.
I accept that this has happened and that it can't be changed.
I get used to the idea that it happened.
I accept the reality of the fact that it happened.
I accept the reality of the fact that it happened.
Turning to religion
I seek God's help.
I put my trust in God.
I try to find comfort in my religion.
I pray more than usual.
Focus on & venting of emotions
I get upset and let my emotions out.
I let my feelings out.
I feel a lot of emotional distress and I find myself expressing those feelings a lot.
I get upset, and am really aware of it.
Denial
I refuse to believe that it has happened.
I pretend that it hasn't really happened.
I act as though it hasn't even happened.
I say to myself "this isn't real."
Behavioral disengagement
I give up the attempt to get what I want.
I just give up trying to reach my goal.
I admit to myself that I can't deal with it, and quit trying.
I reduce the amount of effort I'm putting into solving the problem.
Mental disengagement
I turn to work or other substitute activities to take my mind off things.
I go to movies or watch TV, to think about it less.
I daydream about things other than this.
I sleep more than usual.
Alcohol-drug disengagement
I drink alcohol or take drugs, in order to think about it less.

[61] I shall not attempt an analysis of these factors here. Carver et al. (1989) present an extensive discussion of the role played by individual differences in the coping process, whether dispositional or situational, in the

context of studies involving university students facing various stressful circumstances in their student life. Personality traits like optimism vs. pessimism or trait anxiety, controllability of the stressor, self-esteem, locus of control, hardiness (commitment, control and challenge), Type A behaviour (competitive achievement orientation, sense of time urgency, tendency toward hostility) and social desirability, were the variables studied for their potential influence on the choice of coping tactics. But conclusions drawn by Carver et al. (1989) remain inconclusive.

[62] Though "*performance decrements would be expected when an individual is frightened [and that] the evidence derived from the fear literature supports this view [,] what is little surprising, however, is the relative lack of decrement in some of the studies cited even when the subjective and physiological measures indicate that the individual is both frightened and highly aroused*", possibly due to a "*narrowing of attention*" (Idzikowski & Baddeley, 1983), which can be seen as a pre-cognitive, pre-conscious coping mechanism (Lazarus 1993b).

[63] "*The need for clarity and congruence between organizational macro and micro goals is important in achieving organizational ends, and makes a difference in negative and positive stress […] As goal clarity increases stress goes down*".

[64] "*In a task involving recall, recognition, or some other form of cognitive performance, [it is] the provision of a contextual cue, prime, or prompt that provides information about either the identity or the time of appearance of a target stimulus , […] that influences expectancies of targets, as in associative priming [or in] expectation-dependent priming or strategic priming*".

[65] For Clervoy (2007) "*Le traumatisme est assimilable à un accident de vie. Ce mot englobe dans sa signification la blessure et les dommages liés à la blessure : le terme renvoie à un phénomène d'effraction et de rupture. Il n'entre pas dans le registre des événements prévisibles et il est bien au-delà des ressources adaptatives d'une personne. Il n'y a pas de graduation repérable du phénomène.*".

[66] Overconfidence suppresses possibilities of recognising the situation, affects situation awareness and the repertoire of routines of the individual for Actions Selection in the decision-making process: "*notre système de pensée - qui nous laisse croire que nous maîtrisons tout - décuple les effets de surprise et augmente notre déroute en situation de catastrophe "* Clervoy (2007). Firemen are formatted to believe that they are prepared for the worse as one can understand in the BSP 118 Regulation (BSPP – 2004) : Firemen, by keeping a cool head at all times ("*conserver son sang-froid et sa sérénité*") and by operating in perfect silence under any circumstance ("*opérer en silence en toute circonstance*"), should be able to surmount the difficulties at hand. BSP 118 though does not say if traumatic are included here… However, this spirit of overconfidence seems fairly common among fire-fighters, Putnam (1995) reveals, stressing the cultural belief that Firemen's intense training will suffice to prevent them from being entrapped in wildfires : "*This is a reflection of the prevailing attitude among managers that if we give firefighters more training and better predictions for fire behavior, fuels, weather, and tactics, entrapments won't happen.*".

[67] "*Lorsque survient l'événement traumatique, il n'y a plus aucun effet de routine possible. La personne est prise dans un effet persistant de surprise. Elle éprouve le sentiment intense, bref ou prolongé, atroce, d'être abandonnée. [...] Ineffable : il n'y a plus de mot pour penser la situation.*" Clervoy (2007, p. 42). Also, Lebigot (2005) reinforces the last point when he says that in the experience of trauma the subject is confronted with the only notion for which no mental representation exists in his mind before the confrontation : death, whether his or his kin's, or even victims'. For him, it is this absence of pre-existing cognitive representation that constitutes the essence of the surprise.

[68] "*Le terme de 'déréliction' est employé pour désigner le trouble de la pensée de celui qui ne parvient pas à suivre l'événement. Il désigne un état aigu d'isolement psychique*." Clervoy (2007)

[69] My own translation of "*La dissociation psychique peut être définie comme la rupture de l'unité psychique*"

[70] "*Le terme de dissociation est utilisé pour la première fois en 1845 par Jacques-Joseph Moreau de Tours [5], pour décrire les phénomènes psychiques observés chez les consommateurs de haschich. Il sera ensuite repris par Pierre Janet pour décrire le mécanisme à l'œuvre dans l'hystérie, cette théorie ayant inspiré celle de Bleuler. ".*

[71] My own translation

[72] Gershuny & Thayer (1999) say that "dissociation implies some kind of divided or parallel access to awareness (Spiegel, 1990) in which two or more mental processes or contents are not associated or integrated (Cardena, 1994; Classen et al., 1993), and awareness of one's emotions or thoughts are diminished and avoided (Foa & Hearst-Ikeda, 1996). Dissociation may be regarded as an altered state or fragmentation of consciousness (Marmar, Weiss, Metzler, & Delucchi, 1996; Steinberg, 1995) in which experience is compartmentalized (van der Kolk, van der Hart, & Marmar, 1996).".

[73] "*Il n'y a plus que le défilé silencieux et ralenti des images qui se succèdent.*".

[74] "*Sa pensée s'est suspendue sur 'je meurs'. Le déroulement du temps s'est arrêté.*".

[75] "*(a) identity confusion and alteration (Steinberg, 1995); (b) emotional numbing (American Psychiatric Association, 1994; Briere & Runtz, 1993; Foa & Hearst-Ikeda, 1996; Litz, 1992) which, as conceptualized, is arguably similar to depersonalization and derealization; (c) absorption[75] (Bernstein & Putnam, 1986; Ray & Faith, 1995; Waller & Ross, 1997; Waller, Putnam, & Carlson, 1996); and (d) disengagement or "spacing out" (Briere & Runtz, 1993).*"

[76] Refering to depersonalisation, Crocq (2007a, p9) calls it "*a desperate attempt to keep in touch with the world at the cost of a fragmentation of consciousness*".

[77] My own translation

[78] In DSM-IV, Post Traumatic Stress Disorder (PTSD, classified : 309.81) really depicts the symptoms incurred by an individual in the aftermath of a traumatic episode. Those symptoms can be verified beyond a month after the actual exposure. PTSD is to be distinguished from Acute Stress Disorder (ASD, classified as 308.3 in DSM-IV) the symptoms of which are to be noticed within the four weeks following exposure to the incident. And so, it is only through post-event symptoms that real trauma can be distinguished from acute (maladaptive) stress. Both are supposed in DSM-IV to result from an exposure to an extreme stressor, which may have threatened the subject's very life. Whereas research has largely focused on the Post-Traumatic phase (Crocq, 2007b, p. 15), scientists have also studied the "*clinique*" of the peritraumatic ("immediate") reaction to trauma, and among others, Chief Medical Officers of the French Armed forces already quoted : Louis Crocq, who created and implemented the "Cellules d'Urgence Médico-Psychologique" concept (CUMP, Medico-Psychological Emergency Teams) also a French Army's Psychiatrist and Professor of Pathological Psychology at Paris V University, François Lebigot a French Army's Psychiatrist and Professor of Psychiatry at Paris Val de Grâce military hospital, and Patrick Clervoy a Professor of Psychiatry at the military instruction hospital of Toulon.

[79] For Crocq (2007b), it has both a biophysiological and a psychological component. On the biophysiological side, cardiac and respiratory rythms accelerate, the blood sugar rate increases and blood flows to central organs from the periphery. On the psychological side, four areas are affected :

Cognitive area	Vigilance increases and becomes more proactive while attention narrows on the dangers of the situation suppressing lighter thoughts or day-dreams, situation evaluation and reasoning capabilities are enhanced.
Affective area	A disturbing emotional squall may inspire anxiety or a controlled fear, along with combativeness and possibly indignation or anger, though social relation to others is maintained adequate to the needs of the situation.
Conative area	A pressing need to act, out of an irresistible unpleasant internal urge that can only be reduced by doing something, pulls the subject out of indecision and makes him decide upon his course of action.
Behavioural area	An ordinary reaction of stress leads the subject into a series of fit for purpose attitudes and actions aiming at reducing the threat or at protecting himself ; his gestures are quick though not precipitated, and harmonious though less relaxed than usually.

On a positive side, this stress reaction brings about increased attention, more energy and an impulse toward action. On a more negative side, it consumes all the subject's energy, leaving him in a mix of euphoria and complete physical and psychical exhaustion.

[80] Maladaptive reactions are classified in four families by Crocq (2007b) :

- Sideration

Cognitive area	Stupefaction, incapacity to perceive, recognise and express feelings Loss of sense of identity and location Suspension of decision-making faculties, incapacity to select a course of action

Affective area	Stupor beyond fear Neither jolly nor sad mood, but in a kind of secondary, indifferent state
Conative area	Inhibition of volition Loss of initiative
Behavioural area	Paralysed, petrified, still in front of danger, owing his survival to comrades who pull him away from threats
Duration	From a minute to several hours

- Agitation

Cognitive area	Too much stress to understand properly what is going on and to elaborate actions
Affective area	Affective mess
Conative area	Desire to act but incapable to form a clear volition
Behavioural area	A wild release of disorderly motion or gesture with gesticulation, shouting, inconsistent utterances, … Very disturbed relation to others whom the subject knows he is among them but without recognising them
Duration	From a few minutes to several hours

- Panic escape

Cognitive area	Total absence of understanding of what is going on Unreasoned flee away from the scene Only keeps a fuzzy memory of the course of his actions and of events afterwards
Affective area	Panic
Conative area	Does not know where he is heading to
Behavioural area	Crazy and bewildered running Empty look showing total absence of understanding of the situation
Duration	From a few minutes to several hours, until the subject is exhausted

- Automaton-like behaviour :

Cognitive area	No recollection of their immediate actions
Affective area	Feeling like emerging from a dream
Conative area	Obeys orders
Behavioural area	Does not draw people's attention on him a priori, seems normal, evacuates with others as told, without panicking, possibly helping others out of their own will But on refined observation, the subject's gestures are jerky, repetitive, useless, ridiculous, or ill-adapted Face expression looks "empty" as if the subject were cut from the tragic reality Seems to listen but do not memorise what they are told Keeps silent
Duration	From a few minutes to several hours

[81] For Crocq (2007b), pathological reactions can be :

- Neurotic reactions (based on mild mental disorder, with distressing symptoms, but without loss of insight according to Colman (2006, p. 503)) :

Forms and symptoms	Anxiety : • Docile behaviour after the exposure • Untenable during the exposure with paleness, symptoms of psychological and somatic anxiety, requests for reassurance, agitation, capable of jumping into danger without thinking • ceases as soon as the exposure ceases Hysteria : • Rare at the peritraumatic stage but may happen • Hysterical motion, errand, or immediate conversions such as false blindness, deafness or paralysis, aphony and mutism Phobia : • Rare at the peritraumatic stage but may happen with known phobic subjects • Filled with intense anguish at the sight of the phobic threat, they stay paralysed by terror, needing a reassuring presence to stand the threat

- Psychotic reactions (based on mental impairment grossly affecting the capacity to meet ordinary demands of life, with delusions or hallucination, and a loss of insight according to Colman (2006, p. 620)) :

Forms and symptoms	Confusion : • Disorientation in space and time, obsessed, in stupor, incapable of telling his name • From ten minutes to several days Delirium : • Immediate reaction articulated in a brief perplex meditation, acting deliriously until ending in a state of confused perplexity Maniac : • Psychomotor excitation, tics and mimics, volubility with screams and interjections, euphoria inconsistent with the gravity of the situation • Attracts attention from others usually, but may also engage into tireless participation to rescue operations until he is noticed for his agitation and lack of discipline or his disrespectful annoying joyous interjections of others Melancholy : • Rare at the peritraumatic stage but may happen with known phobic subjects • Reaction based on a deep depression involving psychomotor inhibition, moral suffering, pessimistic exageration of the event's consequences, self-guilt Schyzophrenic : • Especially with young subjects • Dissociative, autistic or delirious reactions had been brooding for a long time

[82] "*De façon plus dramatique, le cas de la femme victime de viol qui a l'impression d'être spectatrice de ce qui lui arrive, incapable de crier ou de se débattre, est une illustration du phénomène de dissociation dite « péritraumatique ». Elle présente un état de sidération, dans lequel les sensations physiques et les émotions sont mises à distance. Dans ce cas extrême, les bouleversements psychologiques et physiologiques suscités par l'agression interfèrent avec l'encodage de l'information traumatique. Ainsi, pour Chris Brewin [26], la dissociation bloquerait l'encodage des événements par la mémoire verbale (appelée verbal access memory «VAM»). Les événements vécus dans un état de dissociation ne seraient donc encodés qu'au niveau sensoriel (par sensory access memory «SAM»), ce qui rendrait impossible l'intégration de ces souvenirs à la mémoire autobiographique « normale » qui est essentiellement verbale.*" Kedia (2009)

[83] "*Because of this our conceptions of ourselves are grounded in experience and constrained by it. Autobiographical memory limits what we can be […] the goals we can hold and delimits what aims the self can adopt.*" (ibid).

[84] Conway conceives Episodic Memory "*as a system that contains experience-near, highly event specific, sensory-perceptual details of recent experiences*" (ibid). *Per se*, episodic memory "*cannot on its own be used to evaluate more complex goals in working-self goal hierarchies. Instead, the organization of groups of episodic memories and abstractions drawn from them, along with attitudes and beliefs of the working self, form conceptual autobiographical knowledge.*" (Conway 2001, p. 54).

[85] Conway's conception of autobiographical memory evolved over time. In Conway (2004), there seems to be no traces of his anterior distinction between episodic memory and autobiographical knowledge on the short-term vs. long-term distinction he was advocating in Conway (2001).

[86] "*sensory-perceptual episodic memories do not endure in memory unless they become linked to more permanent autobiographical memory knowledge structures, where they induce recollective experience in autobiographical remembering. By this view access to episodic memories (EMs) rapidly degrades and most are lost within 24 h of formation. Only thos EMs integrated at the time or consolidated later, possibly during the sleep period following formation, remain accessible and can enter into the subsequent formation of autobiographical memories (AMs).*" (Conway 2001, p. 54).

[87] the "*most abstract and temporally extended […] knowledge about others, activities, locations, feelings and evaluations common to a period as a whole […] a period such as 'when I was at secondary/high school' […] may also contain a more or less detailed evaluation, e.g. 'this was a good/bad time for me' […] mental models of the self during a delineated period of time usually defined by a theme or common set of themes, e.g. school, work, relationship, etc.*".

[88] "*more experience-near than lifetime periods […] contain information about others, activities, locations, feelings and evaluations relating to specific experiences [that] may be of repeated events, […] extended events*".

[89] "*such as learning to drive a car, learning to use the library, romantic first relationship, making friends with X, etc.*".

[90] "*In the formation of a specific autobiographical memory, autobiographical knowledge becomes linked to episodic memories and a stable pattern of activation forms over the indices of autobiographical knowledge structures and associated episodic memories (Conway and Pleydell-Pearce 2000). When this occurs the rememberer has recollective experience – a sense or feeling of the self in the past (Tulving 1985, Wheeler, Stuss and Tulving 1997) – attention is directed inwards to the autobiographical memory, and at the same time other episodic memories and autobiographical knowledge may also come to mind*." (Conway, 2004).

Autobiographical knowledge, Conway says (2004, pp. 562-563), "*comes to mind not in the form of memories but rather in the form of statements, propositions, declarations, and beliefs about the self, often accompanied by generic and / or specific images of details of prior experience*". For the purpose of this study, I assume no demarcation between semantic memory and episodic memory, between declarative and non-declarative memory, first because my research is not about memory itself, and also because of Tulving's (2001, p. 276) revision of "*his own position of 1972*" (ibid, p. 277) who affirms that the memory trace of a single event is "*a 'bundle' of widely but systematically dispersed features organized hierarchically*", and says that these features of the event "*are stored separately in different systems: information about the perceptual features of the input are stored in the perceptual system, information about conceptual and semantic aspects is stored in the semantic system, and information about the involvement of the self in the experiencing of the input is stored in the episodic system*." (ibid, p. 276).

[91] Because "*the excessive arousal at the moment of the trauma interferes with the effective memory processing of the experience [] the resulting speechless terror [leaves] memory traces that may remain unmodified by the passage of time, and by further experience*" (Van der Kolk, 1997). And he adds : "*Personally highly significant events generally are unusually accurate* [in memory] *, and tend to remain stable over time*" (p. 247), "*While memories of ordinary events disintegrate in clarity over time, some aspects of traumatic events appear to get fixed in the mind and to remain unaltered by the passage of time or by the intervention of subsequent experience*" (p. 248).

[92] We do not consider maladaptive and pathological reactions in this study as they are relevant to psychiatry (Luthar et al., 2000).

[93] "*An example of a Critical Incident for an individual would be the serious injury or death of a colleague in the line of duty or an incident where the circumstances, the sights, sounds and smells are so distressing as to result in an immediate or delayed reaction.".*

[94] "*Individuals who experience Critical Incidents can develop strong emotional reactions that have the potential to interfere with their ability to function either at the scene of the incident or later. The severity of distress is influenced by length of exposure, perceptions, the cumulative effect of incidents over time, pre-existing coping strategies, and available social support.".*

[95] *"Peritraumatic reactions [are] the reactions during or in the immediate aftermath of trauma exposure […] Individual differences in genetic susceptibility, sensitization related to prior trauma exposure, and degree of perceived life threat at the time of exposure influence the level of adrenergic activation, a biomarker of peritraumatic panic and dissociation. […] Greater panic-like reactions during exposure (e.g., sweating, shaking, heart racing, fear of dying, fear of losing emotional control, depersonalization, and derealization) are associated with greater adrenergic activation".*

[96] Trauma is a "*singularity in the mathematical sense, a point that comes to belong in the person's life but that is not in the continuity of her history*" which strikes the individual twice, with "*a shock and an after sh*ock", he says (p 275).

[97] "*By definition, a traumatizing event is one that is outside the normal range of everyday life events. It is experienced by the individual as devastating (Doepel, 1991).*".

[98] "*A Critical Incident is one experienced by personnel that produces an emotional reaction with the potential for inhibiting a worker's ability to function either at the scene or at a later time. The individual's coping mechanisms are overwhelmed. An example of a Critical Incident for an individual would be the serious injury or death of a colleague in the line of duty or an incident where the circumstances, the sights, sounds and smells are so distressing as to result in an immediate or delayed reaction.*".

[99] To have the initiative, in the military sense, refers to a very important ability described by Yakovleff (2006) as the faculty to have enough control over the course of events so as to act upon it. It can be lost when events taking the subject aback perturb the planned pace of his action, suppress his margins of manœuvre, or break the story line of his course of action. Initiative, fundamentally, is at stake under traumatic circumstances.

[100] "*Le traumatisme psychique projette la personne dans cette marge, un espace d'attente qui est aussi un espace d'impuissance. La personne traumatisée a perdu pour un temps la capacité d'initiative. Elle ne peut que vivre passivement le spectacle de sa fin. Sa vie ne lui appartient plus. Elle devient le jouet du destin. Le traumatisme prend la main sur elle et seule l'issue dira quel a été son sort.*".

[101] Bertrand (2007) mentions "*the absence of prior ad hoc protecting psychological mechanisms*" : "*Le traumatisme entraîne un double vacillement : le coup et le contrecoup. Sur le moment, la victime est frappée. Après, autour d'elle, tout le monde est ébranlé.*". This is very much in phase with DSM-IV acknowledgement of the subjective character of this experience, people more acquainted with extreme circumstances being less prompt to traumatism.

[102] Spontaneous testimony by Fireman Cyril, 28 year old. Collected Friday 30th of March 2007 from his blog on the Internet at http://loulou95jassume.skyblog.com

[103] This testimony is part of the data collected for this research : it serves to contrast the Pheno-Cognitive Analysis of Lieutenant A's case.

[104] A specific action performed by a subject, not all his actions nor a series of actions

[105] In space and time

[106] In a context, both social-cultural and physical

[107] Lived within our body so that memories of physical moves and sensations are part of the memory of the action : "*subjective experiences are so deeply embodied in our actions and movements and in the physiological shifts*" (Stern, 2004, p. 39).

[108] Effectively performed in the real world, not just seen nor imagined

[109] Engeström (1999), refering to Leont'ev (1978 ; 1981), defines an *action* as the realisation of a particular goal, within the larger context of an "*activity*" understood as a social practice oriented at objects that meet human needs : "*Actions have clear points of beginning and termination and relatively short half-lives [and their goals and plans] are formulated and revised concurrently as one acts and […] are commonly explicated clearly only retrospectively (Weick, 1995).*" (Engeström, 1999, p. 381).

[110] At http://www.bps.org.uk.

[111] At http://www.apa.org.

[112] As of July 25th, 2013.

[113] "*How do people deal with difficult events that change their lives? The death of a loved one, loss of a job, serious illness, terrorist attacks and other traumatic events: these are all examples of very challenging life experiences. […] Resilience is the process of adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress — such as family and relationship problems, serious health problems or workplace and financial stressors. It means "bouncing back" from difficult experiences.*"

[114] As of July 25th, 2013.

[115] PTSD can be seen as "*disturbances in the development of the sense of self and of relationship to others […] commonly manifested […] as pathological object relations and deficits of basic trust, reality testing, autonomy, and affect regulation (particularly rage and aggression)*" (Matthews & Chu 1997).

[116] "*According to Everall, Altrows and Paulson (2006) models of resilience have predominantly focused on one of three operational definitions: (1) a* ***stable personality trait or ability*** *protecting individuals from negative effects of risk and adversity; (2) a* ***positive outcome****, which is defined by the presence of positive mental health (such as positive self concept and self esteem, academic achievement, success at age-appropriate developmental tasks, etc) or absence of psychopathology, despite the exposure to risk; or (3) a* ***dynamic process*** *that is dependent upon interactions between individual and contextual variables, and which evolves over time.*" Metzl (2007).

[117] "*According to M. Rutter (1998), an English Child psychiatrist, the mental health sciences have applied the concept of resilience progressively in five steps. First, they construe it solely as an* ***individual characteristic****; what the individual did under stress. Second, "resilience" integrates the* ***individual's interaction with the environment****, involving also what happened before, during and after the stress. Third, certain specialists deem it a* ***balance of good and bad experiences****. Fourth, in a medical analogy, it is seen as a* ***type of immunization****, where we attain strengthened health by exposure to natural or induced infections. Fifth, researchers recognize that psychological challenges and a certain level of stress are* ***useful and even necessary for human development****; this focus includes emphasis on how to aid children weather adversities actively and successfully*" (Titus, 2002).

[118] "*Although there is a general agreement as to the outcome of resilient behaviour, controversy exists as to the mechanism of resilience. […] Rutter (1987) proposed a* ***process*** *incorporating protective factors. Fine (1991) and Flach (1980, 1988) view resilience as a process which one may be able to learn. […] Fine (1991) discussed the process of resilience with respect to the demands of physical and neurologic trauma in rehabilitation settings. […] Fine (1991), in her work with physically disabled individuals, […] identified a two-stage process of resilience. In the* ***acute phase*** *of the process, energy is directed at minimizing the impact of the stress and stressor. In the* ***reorganization phase****, a new reality is faced and accepted in part or in whole (p 499). Although inspiring, Fine's article is silent on the details of her work. […] The final author to be discussed is Flach. Flach (1988), in a self-help text, identified a normal process of* ***disruption and reintegration*** *which characterizes the life cycle. Resilience is part of the cycle. Using a developmental perspective, Flach presented the idea of '****bifurcation points****… the points in life when major shifts occur'. Similar to Rutter's (1987) key turning points, bifurcation points represent moments of extreme change in the life cycle. The process is cyclical, beginning with a bifurcation point stress which disturbs the homeostatic processes of the individual. This leads to disruption in normal routines and, ultimately, to chaos. At this point resilience is initiated leading to reintegration and a new* ***homeostatic*** *structure at a higher level of functionning.*".

[119] "*Resilience refers to a dynamic process encompassing positive adaptation within the context of significant adversity. Implicit within this notion are two critical conditions : (1)* ***exposure to significant threat*** *or severe adversity; and (2) the achievement of* ***positive adaptation*** *despite major assaults on the developmental process*"

[120] "*For the purpose of this research the term 'resilience' is defined as the ability of an individual to* ***bounce back*** *from adversity,* ***persevere*** *through difficult times, and* ***return*** *to a state of internal equilibrium or a state of healthy being (Brodkin & Coleman 1996; Henderson 1998).*" (Luthar et al., 2000).

[121] "*la résilience renvoie avant tout à l'aptitude du sujet à surmonter le traumatisme. Dans cette optique, l'atteinte traumatogène est considérée comme le préalable à l'émergence du processus résilient. On ne saurait parler de résilience pour des contextes relevant seulement des stress d'ordre banal de la vie. Pour que l'on puisse attester de la résilience d'un sujet qui se développe en dépit des risques, il faut donc qu'il ait*

été confronté à un traumatisme ou à un contexte traumatogène tel qu'il a provoqué un risque vital pour le sujet. Une citation souvent reprise attribuée à Boris Cyrulnik, présente la résilience comme « la capacité à réussir, à vivre et à se développer positivement, de manière socialement acceptable, en dépit du stress ou d'une adversité qui comporte normalement le risque grave d'une issue négative ». Cependant, dans ses travaux ultérieurs, Boris Cyrulnik a précisé que l'on ne pouvait parler de résilience pour un sujet que lorsqu'il y avait eu confrontation à la mort, c'est-à-dire que le sujet avait éprouvé une expérience de danger extrême relevant d'une atteinte corporelle ou psychique." (Anaut, 2006)

[122] "*On peut tenter de cerner la résilience à partir de la définition transversale proposée en commun par Michel Manciaux, Stefan Vanistendael, Jacques Lecomte et Boris Cyrulnik : « La résilience est la capacité d'une personne ou d'un groupe à se développer bien, à continuer à se projeter dans l'avenir en dépit d'événements déstabilisants, de conditions de vie difficiles, de traumatismes parfois sévères. » Cette définition s'attache surtout à l'aspect dynamique de la résilience, en référence au rebond psychologique qui caractériserait le fonctionnement résilient. Dans le processus résilient, il s'agit de souligner la capacité de sortir vainqueur d'une épreuve qui aurait pu être traumatique, ce qui peut conférer une force renouvelée (ou rebond psychologique).*" *(Anaut, 2006, p. 86)*

[123] It refers to the fact that in the post-traumatic phase, an individual must find the ways needed to face what a traumatic encounter entails for him. First the incident often changes his relationship to the world because people around the subject may reproach him to have survived while others did not or because others do not accept to recognise his status of a "traumatised person", possibly resulting in some forms of brutal treatments (Clervoy, 2007). This implies that the individual must adapt to this new relationship to others, hence the idea of an evolution, possibly a deep change in behaviour and even in personality traits. "*Returning to a state of internal equilibrium or a state of healthy being*" means that the subject recovers some psychological balance once events have gone. It is strongly associated with "Preserving identity and a sense of a future", also a post-traumatic developmental perspective. For a Fireman, for instance, it means regaining touch with his feeling that he serves the general population, that he has all the abilities to perform the principal duties assigned to his profession. A sense of shrinking self-esteem is common among BSPP Firemen when, on being wounded in accidents, they are assigned administrative or logistic jobs. Literally, they say they have no future at the BSPP as proper Firemen in such circumstances. "Bouncing back" (Edwards, 2005 ; Gerrard et al., 2004) is an aptitude needed to improve resilience once the experience of trauma is behind.

[124] "*more researchers have suggested conceptualizing coping as part of a complex adaptive system that includes stress, resilience, and competence (Haggerty et al. 1994, Masten 2006). […] coping operates at multiple levels and across several different time scales. As graphically depicted in Figure 1, coping can be considered an adaptive process on the scale of developmental time, an episodic process across days and months, and* ***an interactive process in real time*** *(Coping Consortium 2001).*".

[125] "*In the past, coping has been treated as belonging within the rubric of decision-making, with its emphasis solely on cognitive processes. However, it belongs equally within the realm of motivation and emotion. One*

could just as easily treat coping as a kind of goal, accomplished by certain strategies in a vertical means-ends relationship to each other in which there are broader, overriding ends and narrower means of accomplishing them. Taking into account the specific emotions, general goals (or ends), and situational intentions (or means) to attain goals in stressful encounters would, I believe, facilitate our understanding of the basis on which coping strategies are selected and acted on." Lazarus (1993)

[126] *"At a more micro level, studies will need to consider coping as an interactional process, as it operates at the level of interactions with the social and physical context (bottom of Figure 1), and as captured by observations or daily diaries. Such research would need to include the multiple components of reactions to stress evoked in real time and should specify how they work together in interactions. Studies may use new conceptualizations of coping as regulation under stress to build on what is known about temperament and stress physiology and to create a place for behavior, emotion, attention, cognition, motivation, and social relationships (Derryberry et al. 2003, Gunnar & Cheatham 2003, Holodynski & Friedlmeier 2006).*" Skinner & Zimmer-Gembeck (2007)

[127] I prefer the concept of artefact here rather than resource as objects given to us in the course of experience are artefacts in Engeström's sense for instance and can dynamically – creatively – become solutions to difficulties or deficiencies, proper resources then, i.e., instruments. When Metzl, in her thesis, refers to creativity, her views implicitly refer to theories of creative instrumentation, of *instrumental genesis* described by Béguin et Rabardel, the essence of which is that when a cognitive demand is placed upon me, I search within me and around me for solutions ; an artefact emerges for it affords the characteristics, the potential functionalities I need to meet the demand ; I devise a scheme that allows me to use it as the solution I need ; the artefact then becomes an instrument. Creativity can be viewed as this mental process in the context under study.

[128] "*In the flow of skillful coping, we switch activities as a result of the attractions and repulsions we experience prereflectively (Rietveld 2004). Such emotional fluctuations act as control parameters that induce bifurcations from one Present Moment of consciousness to another. In this way, emotion plays a major role in the generation of the flow of consciousness*" (pp. 374-375). And also : "*Cognitive and emotional processes modify each other continuously on a fast time-scale*" (p. 371).

[129] An "*idiographic*" study in Shaughnessy et al.'s (2006, p. 43) terms is a form of case study. It focuses on a unique subject. *Nomothetic* studies "*try to establish broad generalizations and general laws that apply to a diverse population*" (ibid, p. 42).

[130] Created in 1986 its first president was James Shanteau, followed by Hammond, Dawes, Lopes, Fischhof, Hogarth, Kahneman…

[131] At http://www.sjdm.org/history.html

[132] "*Classical theories of choice in organisations emphasise decision making as the making of rational choices on the basis of expectations about the consequences of action for prior objectives, and organisational forms as instruments for making those choices*" (pp. 11-35).

[133] Part of recent research placed the emphasis on errors and biases, i.e., on the question of why people move away from rationality, and of course on how to prevent errors and biases. Literature on human errors is abundant and has brought about different taxonomies used either in process or in systems design (Rasmussen, 1983 ; Norman, 1988 ; Hollnagel, 1991). And this strand of research has led to many prescriptions, e.g. developing training and establishing good practice guides, such as, in Aviation, the Global Aviation Information Network's (GAIN, 2004) report on Common Pilot/Controller Misconceptions.

[134] Cognitive Task Analysis

[135] "Psychologists have studied skilled performance and expertise for at least 50 years, beginning with the seminal work of Adrian de Groot [1965/1978], who looked at expert memory in chess. During that time, expertise has been studied in many domains including chess, physics problem solving, medical diagnosis, cab driver route knowledge, typing, fire ground commanders, tank platoon commanders, and many more.".

[136] "'*stage' model for the acquisition of expertise*" that describes the expert as "*The individual [who] no longer relies on analytical principles (rules, etc.) [… as he has] an intuitive grasp of situations [… and is] attuned or focused on the relevant aspects of the situation*", providing him with "*fluid, flexible, and highly proficient performance*".

[137] "*The RPD model was developed on the basis of cognitive task analyses of firefighters (Klein et al. 1989). The initial research was designed to better understand how experienced commanders could handle time pressure and uncertainty. […] Probe-question based interviews were conducted with more than 30 firefighters with an average of 23 years of experience, to obtain retrospective data about 156 highly challenging incidents.*".

[138] Regarding Level 1, Klein says "*An example of the first level of the RPD model is a firefighter I interviewed early in the process. He explained to me that he never made decisions. After trying to press him on the issue, I asked him to describe the last fire he was in. He told a story of a fairly conventional fire. He described parking the truck, getting out his hoses, and going into the house. I asked him why he went into the house instead of simply working from outside, as I would have been tempted to do. He explained that he obviously had to go in because if he attacked it from the outside, he would just spread it deeper inside the house. He took into account the nature of the fire, the distance of the house from other buildings, and the structure of the house. But, even while he was attending to these conditions, he never saw himself as making a decision. He never experienced that there was another option. He immediately saw what needed to be done and did it.*" (Klein, 1997b).

[139] *"periods of 'time-constrained decisional pressure' during which naturalistic, immediate, satisficing type decisions were made, co-existing with periods of relative quiet and calm, where 'time-rich decisional opportunities' prevailed. […] characterised by more classical decisional activity with due consideration to a number of possibilities and their likely consequencfes and utility."* (pp. 88-89).

[140] *"Choosing a course of action: decision-making strategies […] In aviation, the calculation of time and risk determines the type of decision strategy a pilot is likely to adopt. Where there is little time and high risk, pilots use fast intuitive or rule-based decision strategies. With more time, they may opt for a slower, but more rigorous, analytical strategy to evaluate alternative courses of action. In the intuitive and rule-based methods, only one response option is considered at a time. In analytical decision making, several optional courses of action are generated and then compared simultaneously. In the creative option, the situation is judged to be totally unfamiliar and requiring a novel response.*"

[141] In Lazarus (1993), we note that "*in arguments between spouses*", there may be an "*escalation of anger*" but also that "*However, in shared situations of anxiety, husbands and wives more often cope by suppressing their anger in the interests of dealing with their joint threat.*", implying that emotion awareness serves to regulate that escalation.

[142] *"What could be more logical than the principle that if our goals are thwarted we react with a negative emotion, or that if we are making satisfactory progress toward a goal we react with positive emotion? This reaction may not always be wise, but there is nothing irrational about it. What is more logical than the principle that emotions result from how we evaluate the significance of events to our well-being? It may be foolish to want certain things, or to believe certain things, but it is not illogical to emote on the basis of how we are faring in attaining these goals.*".

[143] *"Part of the NDM community's reluctance to embrace affect as a component of expert decision making may have to do with the way the construct has been defined and studied by JDM researchers in the past (e.g., Loewenstein & Lerner, 2003; Schwarz, 2000; Weber & Johnson, 2009). Much of the research has examined how people's decisions are influenced by emotions that they bring to the task and that are unconnected to the task at hand. […] Considerably fewer studies concern integral affect, the influence of emotions that are elicited by features integral to the decision situation itself or by its potential consequences.*" (p. 241).

[144] *"Affect has been found to function as "spotlight" or attention guide, as information, as motivator, and as common currency (Peters et al., 2006; Weber & Johnson, 2009). Affect as information approaches suggest that decision makers use their affective state as information in their judgment process (Peters et al., 2006; Slovic, Finucane, Peters, & MacGregor, 2002; Slovic & Peters, 2006)."* (p. 242). Also, "*affect encourages decision makers toward information-processing strategies that preserve positive and avoid negative experiences (e.g., Isen et al., 1988; Weber & Johnson, 2009).*" (p. 243). And affects may constrain information search (ibid, p. 244).

[145] The NCO Grid could be used to compare the cognitive operations explicited through a Pheno-Cognitive Analysis of decision-making and Peritraumatic Resilience with those identified in NDM studies.

[146] The ExpGrid could be used to characterise subjects later studied.

[147] The DMContext Grid could be used to characterise situations in which subjects were involved.

[148] By *deliberative*, we understand a rational process seeking to yield a good decision by way of a "discussion" between cognitive operations described in the NDM framework. Beside, one must consider *automatic* decision-making as relying on routines.

[149] Downing et al. (2007) say metacognition is a long-known concept : "*Although the term metacognition only became part of the lexicon of higher education in the 1970s, when Flavell (1971) introduced the term 'metamemory', the concept is much older than that and, as King (2004) points out, draws on the work of more ancient philosophers like Plato, Aristotle, Confucius, Solomon, Buddha and Lao Tzu.*". Cox (2005) supports this view : "*Philosophers and observers of the human condition have been fascinated by the subject for a very long time. Around the turn of the 16th century in De Trinitate, Augustine [10] asks "What then can be the purport of the injunction, know thyself? I suppose it is that the mind should reflect upon itself".1 Mathematicians and philosophers have realized since at least the time of Socrates the problems associated with self-referential sentences such as the liar's paradox represented by the statement "This sentence is false." ([76]; see [183] for a treatment of some of these metalanguage problems.)*" (p. 107).

[150] Bialystok, E. (1992a). Attentional control in children's metalinguistic performance and measures of field independence. Developmental Psychology, 28(4), p. 654. Retrieved February 14, 2008, from Academic Search Complete database.

Bialystok, E. (1992b). Selective Attention in Cognitive Processing: The bilingual edge. In R. Harris (Ed.) *Cognitive Processing in Bilinguals*, pp. 501-513. New York, NY:Elsevier.

Bialystok, E. (2001). Thinking about Language. In *Bilingualism in Development: Language, Literacy & Cognition*. Cambridge University Press, New York, pp. 121-151.

[151] Thompson, L. & Thompson, M. (1998). Neurofeedback Combined with Training in Metacognitive Strategies: Effectiveness in Students with ADD. *Applied Psychophysiology and Biofeedback*, 23(4).

[152] Tomasello, M. (1999). *The cultural origins of human cognition*. Harvard University Press, Cambridge:MA.

[153] Lin, X., Schwartz, D., ad Hatano, G. (2005). Toward Teachers' Adaptive Metacognition. *Educational Psychologist*, 40(4), pp. 245–255.

[154] Rivers, W.P. (2001). Autonomy at all Costs: An Ethnography of Metacognitive Self-Assessment and Self-Management Among Experienced Language Learners. *The Modern Language Journal, 85(*ii), pp. 279-290.

[155] "*Moreover, meta-cognitive processes have often been portrayed as explicit processes that involve deliberate reasoning (Mazzoni & Nelson, 1998; Metcalfe & Shimamura, 1994). However, evidence has been mounting that metacognitive processes may not be entirely explicit. For example, Reder and Schunn (1996) argued that there were likely to be implicit processes, for the simple reason of avoiding using up limited cognitive resources (such as attention) and interfering with regular processes. Thus, they argued that, while meta-cognitive strategies themselves might be explicit, and/or explicitly learned, the selection (and use) of meta-cognitive strategies was implicit. We have reasons to believe that meta-cognitive knowledge is neither necessarily explicit, nor necessarily implicit (Sun & Mathews, 2003). Meta-cognition is likely a combination of implicit and explicit processes, the same as regular cognitive processes*".

[156] "*whilst cognition focuses on solving the problem, metacognition focuses on the process of problem-solving (Marchant, 2001). In addition to the knowledge people have about how they use their thoughts and strategies (Brown, 1987), knowledge about how much they will be able to learn and what kinds of strategies they use (Gleitman, 1985; Weinert & Kluwe, 1987), people also possess a set of general heuristics. For example, how they plan, set goals and process feedback (Frese et al., 1987). The assumption is that these general heuristics can be either conscious or automatic (Brown, 1987; Flavell, 1987) and they may be highly generalized or specific.*".

[157] Their article often makes reference to behaviourism as a landmark.

[158] "*Knowing-how, then, is logically prior to knowing-that, because such propositions refer to practices that have been observed either by the self or by others. Neither can the propositions be known as true until they have been tested and corrected by observance of performance.*" (Tharp & Gallimore, 1985, p. 458)

[159] "*Rules may encourage the subject to learn new tasks, but these tasks must be learned in the contexts o f eventual application*." (p. 455), and "*learning-how (the actual methods of performance) cannot be achieved by announcing propositions, but only by "exercises corrected by criticisms and inspired by examples and precepts" (Ryle, 1971, p. 221). Translated into the terms of cognitive behaviorism, learning-how is achieved through induced performance, by modeling, by practice, and by differential feedback and contingent responses. And, to some unknown degree, by precept.*" (p. 459). Tharp & Gallimore (1985) quote Ryle, G. (1971). Knowing how and knowing that. In Ryle, G. (Ed.), *Collected papers (Vol.2)*. New York: Barnes & Noble.

[160] "'*What is the use of (rules and propositions) if the acknowledgement of them is not a condition of knowing how to act but a derivative product... ? The answer is simple. They are useful pedagogically, namely, in lessons to those who are still learning how to act. They belong to manuals for novices' (Ryle, 1971, p. 221).*" ("*Knowing-how, then, is logically prior to knowing-that, because such propositions refer to practices that*

have been observed either by the self or by others. Neither can the propositions be known as true until they have been tested and corrected by observance of performance." (Tharp & Gallimore, 1985, p. 458).

[161] "*The results of metacognitive training vary enormously from laboratory to laboratory, from skill to skill, and from child to child. In a review of the literature, Keogh and Hall (1984) suggest that generalization effects seem due to the intensity, length, and nature of tasks of training. Predictability of generalization effects remains at a low level, though such effects are not absent (e.g., Kendall & Wilcox, 1980; Feinberg & Roberts, 1982; Hall, 1979; Zareski, 1982).*" (Tharp & Gallimore, 1985, p. 460), and " *These studies indicate that what an individual can do in one setting, he or she cannot or does not do in another (Rogoff, 1982).*" (Tharp & Gallimore, 1985, p. 461).

[162] "*Brown, Campione, and Murphy (1977) suggest training the ability to stop and think before attempting a problem, to ask questions of oneself and others, to determine if one recognized the problem, to check solutions against reality by asking not "is it right" but "is it reasonable," to monitor attempts to learn to see if they are working or worth the effort. Others have distinguished such components of problem solving as analyzing and characterizing the problem at hand, reflecting on what one knows or does not know that may be necessary for a solution, devising a plan for attacking the problem, and checking or monitoring one's progress (Meichenbaum, 1980; Glenwick & Jason, 1984).*" (Tharp & Gallimore, 1985, p. 460).

[163] Tharp & Gallimore (1985) state that "*There is no need for the meta prefix. […] When the same skills are to be learned in the context of different domains, that requires separate occasions of learning-how. Much "metacognitive" training does include opportunities for practice and feedback in multiple contexts. Any potency of such training may well be due to these practice-and-feedback, multiple context opportunities, and not at all to so-called "metacognitive" elements*." (pp. 461-462). Considering three basic types of cognitive training, respectively "*blind training*" consisting of "*inducing children to perform tasks but are not informed as to why, nor are they told that the activity is appropriate to a particular class of situations, materials, goals, etc.*" (p. 462), "*informed training*" that includes the pieces of information previously mentioned into the induction process, and "*self-control training*" that "*[specifically includes] training of general executive skills, such as planning, checking, and monitoring*.", he asks about each category the question "*Where then is the meta in cognitive training?*" (p. 463) and systematically demonstrates that each form of training can be " *withdrawn from the meta basket*." (p. 463) : "*So long as sound generalization-training programs are mounted that include propositional announcements, and then the potency of the intervention is attributed to the announced propositions, the case for metacognitive effectiveness remains unproven*." (p. 464).

[164] Daniels, H. (2001). *Vygotsky and Pedagogy*. New York:RutledgeFalmer

[165] Goos, M., Galbraith, P. & Renshaw, P. (2002). Socially Mediated Metacognition: Creating Collaborative Zones of Proximal Development in Small Group Problem Solving. *Educational Studies in Mathematics*, 49(2), p. 193-223.

[166] "*Metacognition refers to the ability to reflect upon, understand, and control one's learning. Previous accounts of metacognition have distinguished between two major components, including knowledge about cognition and regulation of cognition (Brown, 1987; Flavell, 1987; Jacobs & Paris, 1987). Knowledge about cognition includes three subprocesses that facilitate the reflective aspect of metacognition: declarative knowledge (i.e., knowledge about self and about strategies), procedural knowledge (i.e., knowledge about how to use strategies), and conditional knowledge (i.e., knowledge about when and why to use strategies). Regulation of cognition includes a number of subprocesses that facilitate the control aspect of learning. Five component skills of regulation have been discussed extensively, including planning, information management strategies, comprehension monitoring, debugging strategies, and evaluation (Artzt & Armour-Thomas, 1992; Baker, 1989).*".

[167] Quoting Bialystok, E. (2001). Thinking about Language. In *Bilingualism in Development: Language, Literacy & Cognition*. Cambridge University Press, New York, pp. 121-151.

[168] "*Recent research indicates that metacognitively aware learners are more strategic and perform better than non unaware learners (Garner & Alexander, 1989; Pressley & Ghatala, 1990). One explanation is that metacognitive awareness allows individuals to plan, sequence, and monitor their learning in a way that directly improves performance.*"

[169] "*an intervention to enhance familiarity with the criterion environment and teaches the skills necessary to maintain effective task performance under stress conditions [with] three overall goals […] : (a) gaining knowledge of and familiarity with the stress environment,(b) training those skills required to maintain effective performance under stress, and (c) building performance confidence*" (p. 193).

[170] Because, on the opposite of normative theories of decision-making, naturalistic decision-making "*is seen as intertwinned with task accomplishment, context-specific, fluid, flexible, and in some respect 'procedure-free' (i.e., lacking prescribed rules […])*" (Cannon-Bowers & Bell, 1997).

[171] "*[…] conscious understanding, ability to talk or write about tasks, and generalizability to other tasks are also important factors in determining whether a given task is metacognitive and this viewpoint is supported by Brown (1987), who agrees that metacognition requires the thinker to use and describe the process of mental activity.*"

[172] "According to Driscoll (1994), there are three basic instructional principles on which Piagetian (cognitive) theorists generally agree: Principle 1: the learning environment should support the activity of the learner (i.e. an active, discovery-oriented environment). Principle 2: the learner's interactions with peers are an important source of cognitive development (i.e. peer teaching and social negotiation). Principle 3: instructional strategies that cause learners to become aware of conflicts and inconsistencies in their thinking promote cognitive development (i.e. conflict teaching and 'Socratic dialogue'). […] The emphasis on social

interaction as a precondition for the training of reflective skills is today shared by many approaches to instruction (Von Wright, 1992)."

[173] "The mental activities involved in acquiring and processing information", Oxford Dictionnary of Psychology, 2nd Edition, 2006, p. 143

[174] "*Two weeks prior to the experimental session, a preexperimental package was mailed to the subjects to allow review of the following scenario materials: (a) overview of the experiment; (b) political/military background for the scenarios; (c) intelligence summary; and (d) rules of engagement*.".

[175] "*often referred to as a research method, when in fact it is a data analysis method. The reason is that protocol analysis is usually employed in conjunction with a single knowledge elicitation task, the "Think-Aloud Problem Solving" (TAPS) task*" (p. 65).

[176] "*each and every statement in the protocol is coded according to some sort of a priori scheme that reflects the goal of the research (i.e., the creation of models of reasoning). Hence, the coding categories include, for example, expressions of goals observations, and hypotheses.*".

[177] "*Also, working backwards from a detailed assignment of each and every statement in a protocol, one can cluster sequences of statements into functional categories (e.g., a sequence of utterances that all involved a forward search or a means-end analysis, etc. (see Hayes, 1989).*"

[178] They might as well be attributed to the low valence (Gusdorf, 1951) of the cognitive experience of those moments.

[179] Hoffman (2005, p. 69) offers a typical example of the logic of Abstraction-Decomposition that shows its inapplicability to the present study. This coding scheme is based on "*research on nuclear safety conducted by engineer Jens Rasmussen at the RIS National Laboratory in Denmark (Rasmussen, Pjtersen, and Schmidt, 1990).*" (p. 67).

Levels of decomposition \ Levels of abstraction	Whole system	Subsystem	Component
Goals			
Measures of the goals			
General functions and activities			
Specific functions and activities			
Workspace configuration			

[180] "*(In the Gulf Coast region)* ***high pressure will dominate*** *(in the summer) ; (High pressure)* ***keeps fronts north of us*** *(the Gulf Coast region) ; (High pressure)* ***keeps cold polar continental air north of us*** *(the Gulf Coast region).*" (p. 70).

[181] Because "*there is compelling evidence that many psychological factors negatively impact on decision making*" (Omodei et al, 2005). HFIP is based on the idea that "*The 'human factors' approach to understanding how people interact psychologically and physiologically with complex task environments is particularly useful for understanding human behaviour in safety-critical situations, regardless of whether these are essentially manmade (e.g., an aircraft cockpit) or naturally occurring (e.g., a wildland fire) (cf, Johansson, Hollnagel & Granlund, 2002).*" (ibid).

[182] Omodei et al. (2005) say that "*typical strategies for obtaining retrospective self-reports, such as structured interviews and surveys, cause some psychological processes to be much more likely to be recalled than others, leading to a distorted understanding of the decision making process*" in conjunction with "*What is least likely to be recalled are those perceptual, affective and motivational states that are essentially pre-verbal or at least not verbalised during the flow of the decision incident in question. […] Thus, those experiences least likely to be recalled are those associated with actual or potential errors precisely because such experiences constitute a negative self-assessment and, as such, are subject to self-enhancement / protection processes (Omodei, Wearing, & McLennan, 2002).*".

[183] See Henwood (1994) and Bryman (1984) for a distinction between the terms epistemology, methodology and method.

[184] Equivalent to what Conway (2004) calls "*mini-histories*" : "*learning to drive a car, learning to use the library, romantic first relationship, making friends with X, etc.*".

[185] Deahene et al. (2006) have characterised the notions of conscious and pre-conscious information encoding in the brain. In the case of conscious encoding, "*Processing receives top-down amplification and expands into a global parietofrontal reverberant state*". Pre-conscious encoding "*involves local resonant firing loops, but top-down attention is focussed on another stimulus or task set*". See also N. F. Dixon's article on "Subliminal perception" in Gregory (2004, pp. 884-887).

[186] Introspection was defined by James (1890) as "*the looking into our own mind and reporting what we there discover*" (p. 185).

[187] Though Transcendental Phenomenology does not play a part in this research, it is worth noting its methodological principles as they are often refered to in psychophenomenological studies. Studies of the phenomenal experience with the method of Transcendental Phenomenology aim at unveiling the "*what it is like to experience this or that*". For instance, Moustakas (1994, p. 140) reports : "*The experience of feeling guilty is felt as an intensive and permeating reality. Everything else fades in comparison. […] The world, for*

the one experiencing guilt feelings, is an alien world – a being in limbo, with unreal and cloudy forms dimly perceived". The phenomenological method is mostly used for purposes outside the scope of the present research. For instance, Petitmengin (2008, p. 139) presents a phenomenological report from a patient affected by epilepsy constituted mainly of a series of the subject's general knowledge of what it is like to undergo an epileptic crisis. Barclay (1995) interviews A.S., a concentration camp survivor, in an attempt to *objectify metaphors of the self* through a lifetime narrative, spanning from her detention until recent times. The object of such research is very different from a study of the cognitive experience of specific events. For McGinn (1991, p. 101) their principle is that "*subjective experience might be describable in objective (though non physical) terms*". The method of Transcendental Phenomenology follows a succession of principles or steps :

- ***"Epoche"***, i.e.,the suspension, the "*bracketing*" of the usual researcher's perspective, the suspension of his "*natural attitude*" (Thompson, 2007, p. 20), which in hard sciences consists in considering "objectively" the world, as a physical, absolute, objective given, in favour of an attitude that considers that the subject constitutes progressively an "abstraction" of his world of life through his own experience : this is the role of *phenomena* all of which are different *perspectives* on the world, the *variation* of which is the essence of this abstraction. It requires "*the flexible and trainable mental skill of being able to suspend both one's inattentive immersion in experience and to turn one's attention to the manner in which something appears or is given to experience*" (Thompson, 2007, p. 19). Epoché is considered to be the first step of *Reduction*.

- ***"Reduction"***, as redirection (*reducere*) of the attention toward the inner subjective experience of the world, away from the objective outer world (Thompson, 2007, p.18). It is "*a 'leading-back' (reducere) or redirection of thought away from its unreflective and unexamined immersion in the world to the way in which it appears to us*" (Thompson, 2007, p. 25). For Moustakas (1994, p. 90), phenomenological reduction is "*the task of describing in textural language just what one sees, not only in terms of the external object but also the internal act of consciousness*".

- ***The explicitation of intentional "mental operations" and of time in consciousness*** : in its structural and temporal acceptions, it is first the explicitation of the *noesis-noema* coupling in its dynamic emergence. Objects are brought to awareness either by "*re-presentational, presentational or protentional acts*" (Thompson, 2007). *Presentation* refers to the current perceptive or proprioceptive experience, *re-presentation* refers to remembering items of past experience, and *protention* refers to the imagination or anticipation of future phenomena (Thompson, 2007, p. 25 ; Marbach, 1993, p. 10). Presentations, re-presentations and protentions are not autonomous and distinct in the sense that their *affective allure* or *meaning* inter-relate them (Thompson, 2007, p. 25, chapter 9 ; Keen, 1975).

- ***The explicitation of "Meanings"***, the "*content*" of a "mental act", "*inseparable*" of its "object" in Moustakas' (1994, p. 56) terms, that gives a *phenomenon* its "*particular constitution*" (ibid). Meaning is at the heart of Transcendental Phenomenology as the link between the experienced thing and the thing in the real-world, what makes sense of the latter and constitutes its abstraction in the subject's mind.

- ***The synthesis of the "Essence" of the thing under study***, i.e.,the "*eidos*", the pure ideal thing, the abstraction in the subject's consciousness (knowledge) of the object that stands in the real-world, gained from the variation of its subjective experience (Husserl, 1977, p. 54). It is that which "*holds up amid variations [of the way we experience the real-world object] of an original [as] the invariant, the necessary, universal form, the essential form, without which something of that kind, like this thing as an example of its kind, would be altogether inconceivable*" (Spinelli, 1989). In Transcendental Phenomenology, the search for the *eidos* of an event or thing is a synthesis of the various comprehensions one has had of that event or thing. Through "*imaginative variation*", i.e., a confrontation of different meanings of the event or thing in question, the researcher aims at finding out what it is like for a given set of individuals, i.e., its "*invariant*" form. Transcendental phenomenological research is usually carried out to study situations experienced by communities, or repetitively by an individual over a period of time, differently at different moments and in different places (Moustakas, 1994, p. 29).

Moustakas (1994, pp. 181-182), and its quotation by Creswell (2007, pp. 60-62) although with some differences, suggest the following steps to perform a phenomenological study :

1. Preparing to collect data : research question, literature review, participants selection, interview framework

2. Collecting data : Epoche process, bracketing the question ["*as a way of creating an atmosphere and rapport for conducting the interview*", says Moustakas (1994, p. 181), which per se is confusing as *epoché* has nothing to do with contracting the interview nor priming the subject], conduct interviews (informal, open-ended questions, or topical-guided). The examples provided in Moustakas are not very probant: the example provided pp. 117-188 does not relate a specific occurrence of experience but yields a generalisation, a theorisation of habitual patterns of behaviour ("*I am a very restless sleeper. I'm always rolling over and …*". In this example, we must note that such generalisations are already based on interpretations made by the interviewee himself : therefore there is no single chance of getting to the "what it was like to experience insomnia on such particular day". To unveil the subjective experience and at the same time to reduce the hermeneutical bias of interpretation, we need to reject personal theories both from the researcher and from the subject.

3. Organising, Analysing and Synthesising Data

4. Summary, Implications, and Outcomes.

In fact, Moustakas, in Moustakas (1994), does not really provide a set process. Rather, he presents alternatives, various methods taken from other authors that he proposes to enhance. Particularly significant is chapter 7, Phenomenological Research: Analyses and Examples. The phenomenological analysis (step 3) takes a researcher, says Creswell (2007), through "*the data […] and highlights 'significant statements', sentences or quotes that provide an understanding of how the participants experienced the phenomenon*", in

a step called "*horizonalization*" followed by the development of "*clusters of meaning*". Moustakas (1994, p. 122) is more precise, mentioning the following analytic activities : *horizonalization* [The identification of the horizons of experience proceeds from "*listing every expression relevant to the experience*" (Moustakas, 1994, p. 120)], *delimitation of invariant horizons or meaning units* [The method for their identification is not very clear and somewhat confusing with regard to Husserl's notion of horizon : either they are obtained by retaining expressions containing a moment of the experience said by Moustakas to be "*necessary and sufficient*" to understand the experience, or by finding out which expression is "*possible to abstract and label*", or else (Moustakas, 1994, p. 122) by retaining "*non repetitive, non overlapping statements*". Horizons are social, temporal, physical, intellectual, emotional, intentional, retentional, protentional, etc…], *clustering invariant constituents into themes*, *individual textural description*, *individual structural description*. Once these steps have been followed by each researcher, a *composite textural-structural description of the meanings and essences of the experience* is constructed. The phenomenological method examplified by Moustakas and Creswell is not focused on cognition in action and specific episodes of experience. It accepts elements of retrospective theorisation and generalisation within first-person narratives and is highly interpretative due to the subjective way by which it seeks eidetic generalisations in the analysis phase.

[188] [Husserl (1977, p. 2) also mentions Müller, Weber, Volkmann, Helmholtz, Hering and Fechner but akcnowledges the "*organising power of Wundt*"]

[189] They are : "*doctrinaire arguments about which building blocks of consciousness are really fundamental*" (Keen, 1975, p. 137) ; the evolution of early Phenomenological Psychology toward Husserl's Transcendental Phenomenology brought it too close to pure philosophy (Spinelli, 1989, p. XI) ; the "*limited and dubious value*" of the views expressed by some phenomenological philosophers like Heidegger who was "*notorious for the obscurity of his language*" (Spinelli, 1989, p. XII).

[190] From a "splendid impetus from leading German pshysiologists and physicists" (Husserl, 1977, p. 2).

[191] Dilthey (Husserl, 1977) called for "a scientific analysis, formation of concepts and systematic description, carried out on a purely intuitive basis".

[192] Husserl (1977) : "not only the descriptive exhibiting of the types of single psychic data, but also the types of nexus" for "the single datum is a mere abstraction in the psychic. A feeling, a mood, an emerging thought, a hope which makes itself felt, etc – nothing of the sort is ever an isolated lived experience; it is what is in the psychic milieu, in its intertwinnings, its motivations, indications, etc.; and these are moments of the nexus, of the psychic function, which are lived together inseparably".

[193] Husserl (1977)

[194] {noesis ; noema} in husserlian terms ("noesis" in husserlian language,"the subject's essential capacity of building up his own world" (Thinès, 1977, p. 57), which are and are "able to constitute (disclose or bring to

awareness) its objects" (Thompson, 2007, p. 17) ; a mental object is called "noema" in husserlian language. "Noema is that which is experienced, the what of experience, the object-correlate. Noesis is the way in which the what is experienced, the experiencing or act of experiencing, the subject-correlate" (Moustakas, 1994, p. 69).)

[195] Intentionality is the very nature of consciousness, the "Pact between the Mind and the World" (Rouger, 1969).

[196] A fundamental question of Phenomenological Psychology is to understand what makes consecutive mental operations cohere into the production of a sensemaking experience rather than occuring in absolute disconnection of meaning into a senseless episode of experience. Dilthey advocated the principle of the "*unity of psychic life as a unity of the lived experience*" (Husserl, 1977, p. 6). Husserl (1977, p. 165) views the unity of the I as a construct of one's history, and the constructed I, the Self, overlooks and controls new cognitions in an aspiration to *self-preservation*, "*to remain true to itself insofar as it is no longer inclined to abandon its convictions*". Continuity is the idea of a self-regulation, of "*circular causality*" (Thompson, 2007, pp. 61-62) in which the "*global*" controls the "*local*" while the "*local*" influences the "*global*", through three forms of "*emotional self-organisation*" (Lewis, 2000) : Emotional-Interpretations that occur in the instant (seconds to minutes) and are driven by occupational intentions and goals ; Moods, that develop over hours to days, and are governed by intentional orientations, goal preoccupations, inhibited or unsuccessful action ; Personality, which develops over months and years and is controlled by the sense of Self progressively constructed by the convictions of the I. Continuity is also the idea that cognition-in-action is controlled, maybe only to some extent, by mental stories. They are of three types (Conway, 1995) : 1) the *life-story* to which Conway (1995) refers as *lifetime autobiographical knowledge*, 2) *occupational stories* likely to last for years, lived in several "*sociohistorical systems*" i.e., "*social networks or institutions*" (Bujarski et al., 1999, pp. 222-224) and between "*sub worlds of life*" (Schutz, 1987), and 3) the *circumstantial story* at hand to which Conway (1995) refers to as *event-specific*. Mental stories are landmarks one uses when in need of sensemaking, to select local representations and cohere them into a global representation (Pennington & Hastié, 1986, 1988, 1992) or to "*preserve plausibility and coherence, something that is reasonable and memorable, that embodies past experience and expectations [… and] holds disparate elements together long enough to energize and guide action, plausibly enough to allow people to make retrospective sense of whatever happens*" (Weick, 1995, pp. 60-61). Theron (2005) studies how mental stories compete with one another to focus and distract subjects' attention, leading to a minor train accident. Consciousness is a rolling process of mental operations with a fundamental quality : its continuity. The consistency of consciousness stems from a global process : its "historiality" (we cognise through stories), and from a local process : "emotional self-organisation" (our cognition is influenced by affects of different scales) governed by circular causality, the reciprocal influence on the flow of consciousness of global and circumstantial goals. The creation of sense, or its modification, takes place when something triggers it. Acting in the world, we face situations and react to them. Cognition takes place within the time spanning from the instant we encounter a new situation – a change in the world, in our body or in our mind – and the

instant the sensori-motor faculties of our body are activated to deliver a reaction with an impact on the surrounding world.

[197] Which differs from *chronos*, the always-passing-away threefold {past, present, future} structure.

[198] My own translation

[199] My own translation

[200] My own translation

[201] My own translation

[202] My own translation

[203] My own translation

[204] My own translation

[205] My own translation

[206] There are two reasons to this choice. 1st-Person narratives often start with a "once upon a time I was …" clause : the individual is being-in-the-world, he is faced with circumstances or he is doing something, or he just stays there. Also, from a practical perspective, if we started from a cognitive happening, which one should we choose ?

[207] In this sense, the trigger of the PM is the stimulus of the first decision cycle of this PM.

[208] Expliciter is the GREX's quarterly review. GREX is the Groupe de Recherche sur l'EXplicitation started by Pierre Vermersch in 1988. Conceived as a work-in-progress media to enter into a dialogue with other researchers and professionals interested in the explicitation of the subjective experience, Expliciter can be accessed at www.grex2.com.

[209] My own translation

[210] Here, we can note the proximity of goals with Rassmussen (1985).

[211] My own translation

[212] In this sense, the EI is a contribution to metacognitive learning.

[213] In this sense, the EI is a metacognitive training process.

[214] My own translation : "*D'une certaine manière, nous l'avons vu cet été avec le thème de recherche du "Sentiment intellectuel", il ne suffit pas d'avoir une méthode de production et de recueil de verbalisation pour cerner un objet de recherche. Il ne suffit pas de savoir mener un entretien, fut-il d'explicitation, ni de savoir opérer une description, pour parvenir à produire des données intéressantes qui font avancer l'intelligibilité du monde intérieur. Pour atteindre un tel objectif, il faut disposer d'un modèle hypothétique de ce que l'on veut étudier, qui permet de générer de nouvelles questions. Il faut pouvoir orienter son regard dans la bonne direction pour apercevoir des propriétés qui sont là devant nous, mais qui ne se révèlent que si on a l'idée de les questionner. (Ce que je dis là n'est pas mystérieux, je l'ai développé dans mon intervention au GREX sur "Pourquoi est-il si difficile de décrire son propre vécu". Si vous allez dans un jardin, vous ne verrez, et ne pourrez décrire qu'à la hauteur de vos compétences de botanistes ou de jardinier. Et cela n'est pas passif, cela suppose regarder certaines plantes en "changeant la direction de son regard", certains détails n'apparaissent que si l'on sait, par exemple, aller se mettre sous les feuilles parce que c'est là où on peut voir s'il y a des parasites.)*". (Vermersch, 1999)

[215] It allows "*to generate new questions*" and to "*turn our eyes into the right direction to spot properties that stand there before us, but that came into the spotlight only if the researcher questions them [like when] you visit a garden one won't see and describe it only to the extent one owns a competence in botanics or gardening. And this is no passive attitude but supposes to look at plants from 'a new angle', certain details appearing only if one knows, for instance, to look at leaves from beneath as it is only from that perspective that one can spot parasites for instance.*".

[216] Literally "*Informations satellites de l'action*"

[217] Literally, untranslated from Vermersch

[218] Phenomenography also designates a method used in Education Science (Webb, 1997) "*to find and systematize forms of thought in terms of which people interpret aspects of reality […] a research method for mapping the qualitatively different ways in which people experience, conceptualize, perceive, and understand various aspects of, and phenomena in, the world around them*". He claims phenomenography has "*a 'qualitative' rather than a 'quantitative' orientation*" and seeks "*an empathetic understanding of what is involved*" in the cognitive processes of learning and that it is "*exceptionally rigorous*" as "*it sets out to identify concepts which describe important differences in the way students learn and study.*". In this sense, it seems to be very close to Vermersch's psycho-phenomenology. But in a critical stance Webb (1997) also argues that due to this "*tension between the 'empathetic understanding' [and the] reference to 'rigour' and 'scientific research'*", phenomenography seems "*to have more to do with the quest for positivist*

generalisation than the development of hermeneutical understanding". Searle (1985) also suggested a formal description of the cognitive experience.

[219] Let's recall that the "*static*" husserlian phenomenological view refers to the "*correlational structure of intentionality*", as described by Thompson (2007, pp 24-25), the "*invariant structure of intentional act / intentional object […] known as 'noema' (the object in its givenness) and the 'noesis' (the mental act that intends and discloses the object in a certain manner)*". The "*dynamic*" phenomenological view refers rather to the "*emergence*" (Thompson, op. cit., p 29) of phenomena in the subject's cosciousness, of his mental acts, whether out of "*passive genesis*" understood as "*being involuntarily influenced and affected by something*", or out of "*active genesis*" which equates to "*subjects [playing] an active and deliberate productive role in the constitution of objects [the products of which] are tools, artworks, scientific theories, experimental interventions, logical judgments, mathematical propositions, and so on.*". The word "*constitution does not mean fabrication or creation […] 'To constitute,' in the technical phenomenological sense, means to bring to awareness, to present, or to disclose.*" (Thompson, op. cit., p 15).

[220] Brain studies give support to this hypothesis. The mechanism that sparks new mental operations, the "*descending attentional amplification*" mechanism, according to Naccache (2006, p. 274), works as follows. At the "*1/10 Brain Time-Scale*", i.e., between 10 and 100 millisecond (Varlea, cited by Thompson, 2007, p. 331), in the region of a thousand unconscious mental representations are presented by local networks to the central network. If the central network is actively engaged in a global mental operation [which occurs in the 1 Time-Scale, i.e.,between 250 millisecond and several seconds] at that moment then these inputs will be rejected, but if it is in a phase of transition [One of Varlea's experiments reported by Thompson (2007, p. 335) suggests that a transition phase might last around 250 milliseconds and be in Varela's (1999) "1" Brain Time-Scale.], a "*discussion*" is started between the central network and the local networks, those discussions being in the 1/10 Time-Scale (Naccache, 2006, p. 276). Then, they – or some of them – traverse "*in a flash*" (Naccache, 2006, p. 277) the central network, which is massively interconnected. Suddenly, one of these flashes will gain the central network's attention, for either it has some kind of *familiarity* and echo in consciousness, or it has an "*emotional value*" that signals a danger or is related to episodes of our past experience that have left their mark in our autobiographical memory, or else because they fulfill an *expectation* of our consciousness. If a "*critical threshold*" is reached, then that particular discussion whose flash was noticed becomes the object of an increased exchange between the central and the *ad hoc* local network, and other discussions fade away, the elected disucssion is "*amplified*" from within the central network and sparks throughout the whole Global Workspace and the new, corresponding, mental operation, equivalent to Varela's *large-scale dynamic neural assembly* (Varela, 1999 ; Thompson, 2006, pp. 329-338), is performed at the "*1 Time-Scale*", i.e., from 250 millisecond to several seconds in Tompson (2007, p. 333), "*some tenths of a second*" for Naccache (2006, p. 278). Note that the "*10 scale*" is the time-scale of "*descriptive-narrative assessments involving memory*" (Thompson 2007, p. 331). The conscious mental representation, i.e., cognitive operation, synthesises the unconscious mental representations provided by *distinct neuronal populations* (Naccache, 2006, p. 280). This mechanism, free of any "*central monitor*" in the characteristic *self-organising, autopoietic* manner of dynamic systems (Naccache, 2006, p. 281 ; Thompson,

2007, pp. 37-65), serves three complementary and distinct purposes : the amplification of local unconscious mental representations, and the election of one of them at a time in the central neural network ; the circulation of representations from one local processor to another so as to give birth to new mental representations ; the learning and progressive routinisation of skills.

[221] We can hypothesise that in the opposite case, fire-fighters are injured, or even killed, events for which specific reports and statistics can be found.

[222] To simplify the writing of the data processing and data analysis parts of this report, by cognitive operation we mean both a "cognitive operation" (perception, thoughts, emotions, etc…) and an "action" or a "state" (doing something, being or standing somewhere, speaking, moving, …). Both are pairs of {act ; object}. A CogOp is a pair of {CogAct ; CogObj}. An action is a pair of {Act = doing ; Object = something}.

[223] DMA = Decision-Making-in-Action, the cognitive process of a decision-making cycle.

[224] Emotional tone, noise, location, peripheral actors, physical environments, …

[225] In practice, this revealed to ve very difficult at the BSPP : Firemen were available only during service hours at the station ; we were allocated rooms sometimes not so secluded : a gymnastic hall, a dining room, … And fire stations are very noisy : fire alarms resonated very often, I would say roughly ten times in an hour. Sometimesn EI's were interrupted as the subject being on duty (this is why he was at the station) had to go for an intervention and I had to wait for quite a time then until he returns and restart the interview. That was fairly uneasy but feasible.

[226] In Vermersch's EI training session of September 2007, this point was very important.

[227] I insisted clearly, at the contractual stage of the interview that should the subject feel uncomfortable he could terminate the interview at his convenience and that his decision would not be challenged. Also, I watched carefully for signs of overwhelming emotions while the interview was in progress. I notice, with men, a form of agitation in the narration characterised by hesitations, repetitions, interruptions of the speach flow, and with women humid eyes and redish throats. When I noticed those signs, I suspended my questionning, gave the subject as much time as he needed to get over, suspend the narration or possibly close the interview, and precautionously asked if they were all right.

[228] Some subjects are totally incapable of speaking in the first person and this must lead to discarding their interviews. At the same time, some use the impersonal form "*one*", i.e.,"*on*" in French. In this case, interviews must not be discarded straight away as the question is : what does "*one*" stand for ? It might be a collective "*we*" (meaning that the subject cannot express his personal experience but only collective interpretations, for whatever reason that can be discussed after the interview), or a narrative style reflecting the subject's narrative position at recollection time (as a spectator of what he or she experienced rather than a

re-presentification of that past experience). Alternatively, it could be a manner of embedding one's whole experience into a single utterance to say how common this particular item was, meaning : "*I perceived or thought that at the time, but now, at recollection time, in fact when I do so I know that in such a case it is always like this*". This would be the sign of a most unwanted retrospective re-interpretation of the original experience. In an email he sent me on January 6th, 2010, Pierre Vermersch told me that the use of "*one*" might also be connected to a cultural habit specific to the subject's community provided that beside the phenomenological quality of his narrative could be established.

[229] The researcher must clearly state that he is not there to judge the person or the narrative, that there are no good nor bad elements in the narration and in fact that everything narrated is of interest as it can reveal meaningful to the research.

[230] The GREX's quarterly publication

[231] In annex 2, our *Information Form*, validated in its English version by the Ethical Committee of the University, is reproduced.

[232] Vermersch says "*position de parole incarnée*" : literally "*embodied speech position*" (p57)

[233] *Re-presentification* is the state of mind by which the subject's attention is pulled away from the present experience of the Elicitation Interview, including his present attitude (Robinson, 1995), and focused entirely on *re-experiencing now* a given episode of past experience. Once the subject has accepted this principle of the Elicitation Interview at the contractual stage, for him it becomes easier to focus on "*re-living the situation, to find it again, to get in touch with it*" says Vermersch (2006, p. 57), who adds that "*under this narrative stance, the past situation is more present on the subject's mind than the present interlocutary situation […,] the subject focuses his attention more on what he recalls from within than on his relationship to the interviewer […] and can stay in that state of evocation of the past situation to describe it for himself and to inform himself while informing the interviewer too*" (ibid).

[234] Two alternative narrative stances to avoid in an Explicitation Interview are *Generalisation* (the subject only narrates elements of his *a posteriori* theorisation of similar events or of his whole life experience ; that translates into formulations like "*usually when this happens you do not do this but… ; In general one does this ; In such circumstances one thinks of his team mates ;* …".) ; and *Reconstruction* (the subject delivers a narrative that reinterprets his experience in the light of the values of his social milieu. That stance is often expressed by reports of personal conduct, sometimes heroic).

[235] Presence to one's body as it was experienced at the actual time of the event

[236] Presence to one's world-of-activity as it was experienced at the actual time of the event

[237] My own wording : Vermersch says "*questionnement descriptif*" : "*descriptive questionning*", literally (2006, p. 86). Subjective refers to the fact that during the EI the researcher subjectively appreciates the way the subject responds to probes and the way the narration goes. Subjective cueing is subjective because it is an adjustment to these perceptions of the researcher.

[238] Vermersch distinguishes *Pre-conscious* : Elements of autobiographical knowledge that once were fully conscious but which are not at the present moment from *Pre-reflexive* : Elements of autobiographical knowledge never conscious, never verbalised, the unnoticed consciousness of the experience of a course of action, that remains to bring to consciousness by way of a *reflection* process. Vermersch (2006, p. 210) says that "*cognition is mostly pre-reflexive, without any necessity for reflective consciousness to be permanently at play*". Pre-reflexive cognitions are most common in the flow of consciousness. For instance, when one walks, say in a forest, one may be thinking of his current research and his attention is merely attracted to other aspects of one's experience of the walk. But, while attending so strongly to intellectual matters, one perceives many elements : smells from the pine-trees, the light between tree branches, a change in the brightness of the light, the shape of the ground, turning left, etc… These elements, though recorded into autobiographical memory, are not made conscious, i.e., are not *reflected upon* at the time of the experience. *Reflection* is the process by which pre-reflexive knowledge is brought from the concrete level of mere doing to the semantic level of a representation. That representation, says Vermersch (2006, pp. 80-81), makes sense for the subject in the light of his *internal interpretative framework*, it is an *interiorisation*, "*creation of a new psychological reality*" (ibid, p. 81). it is "*a conceptual elaboration*" (ibid, p. 85).

[239] "*Everyone has the capability to recall [even] one's own pre-reflexive autobiographical knowledge*" says Vermersch (2006, p. 82).

[240] In **bold** characters, the researcher's utterances. My own translation. More examples can be found at www.grex2.com.

[241] My own translation

[242] My own translation

[243] Wrong, inadequate, untrue

[244] My own translation. Here, I actually chose not to quote Vermersch exactly to term the probe in a more colloquial English

[245] When saying right or left here, this means to the subject's right or left, i.e.,to the researcher's left or right conversely. Should the subject's eyes redirect to up right, it usually means that he is elaborating the image whereas up left means he evokes the image. When eyes move to the subject's right, he elaborates the auditive memory, whereas to his left means he evokes it.

[246] For instance, imagine yourself facing two aggressive dogs showing signs that they are intending to attack you. They show their teeth, they are growling, their posture is one of threat or fear. You are in no position to escape. You look for a way of showing them that you are not afraid of them with a hope to dissuade them to give up. You feel that you are becoming just like them, an animal with ad hoc bodily capabilities. You have clawsed paws. You feel they are articulated and you could bend your back, and in case they would charge that you would also charge and with your paws knock them down like a lion would do to a bull, right on their head or on their back, just like in that documentary you saw on television the other day. And suddenly your attention is drawn to a kinesthetic feeling : your fingers have tightened around your hand, your feel your hand is ready to knock them. That kinesthetic change was not conscious, inspired by that flow of intense thoughts.

[247] My own translation

[248] My own translation

[249] By refocusing the subject's attention on these moments.

[250] Video-recording can be useful *a posteriori* to elicit non verbal indicators and to reflect on the evocation process and on the conduct of the interview. But, out of experience, I would say that in the course of the interview it is unnecessary as the researcher is totally absorbed by subjective cueing. A hidden observer, discretely radio-linked to the interviewer, would be more useful : he could look for key moments in the story narrated by the subject and attract the attention of the interviewer to suggest focusing or elucidating probes.

[251] Stanghellini (2004) describes the epistemological and heuristic characteristics of psychiatric interview techniques. Their fundamental purpose, which neatly differentiates them from the Elicitation Interview, is to assess the reality of psychopathologies of patients referred to a psychiatrist in reference to codified characteristic signs and symptoms. An alternative, but less *mainstream* approach to the psychiatric interview, Stanghellini (2004) says, is a *free-format and insight-oriented* report aiming at creating *a special instance of interpersonal rapport* between therapist and patient. Such reports can be found in the Schizophrenia Bulletin at http://schizophreniabulletin.oxfordjournals.org..

Another technique is the Cognitive Interview described by Memon et al. (1997) and elaborated by Fisher & Geiselman (1992) as "*a procedure designed for use in police interviews involving witnesses*" to augment the accuracy and richness in details of their testimonies. Drawing "*upon experimental research on memory [it] is presented as a package of techniques that can be used to facilitate memory search and retrieval*". Its steps include :

- Context reinstatement, i.e. the "*mental reinstatement of the physical and personal contexts that existed at the time*", which "*involves (a) emotional elements ("How were you feeling at the time?"), which may work via state-dependent effects (Eich, 1980), (b) perceptual features ("Put yourself back at the scene of*

the crime and picture the room; how did it smell, what could you hear?") and (c) sequencing elements ("What were you doing at the time?").".

- Report everything, in which witnesses receive "*instructions to search for details extensively (which can lead to the recall of additional relevant information (Geiselman & Fisher, 1988)*".

- Reverse order recall, which is probed by a question like "*Tell me about the very last thing you remember in the magic show and then what happened before that, and before that, so you're working your way back to the first thing you remember*". That question is "*placed towards the end of the interview so that any extra information it elicited could be identified.*". More generally, witnesses are asked "*to recount events in a variety of orders (Loftus & Fathi, 1985)*".

- Varied perspective recall : witnesses are asked "*to recount events […] from a variety of perspectives (e.g., the perspective of the victim, suspect, another witness)*".

In their study, with children aged 8 and 9, of the efficiency of the Cognitive Interview, Memon et al. (1997), "*divided [the interview] into the following phases:*

- *Rapport. Boggs and Eyeberg (1990) pointed out that the essential first phase of the interview is to establish rapport between child and interviewer. […] An important part of the rapport building was the transfer of control from interviewer to interviewee (which included active listening, not interrupting and effective use of pauses). As part of this transfer of control the interviewer makes it clear that he or she does not have the information about the event but rather it is the child who holds the information.*

- *(ii) Free recall phase. […] interviewers were asked to request a free narrative account from the witness and this was used as a strategy for obtaining information in the subsequent questioning phase. [and] in addition they were given training in encouraging witnesses to reinstate the context mentally […] before they began. The CI interviewers also employed the `report everything' instruction at this stage.*

- *(iii) Prompt Phase. At the end of the free recall phase, […] interviewers paused briefly and used one prompt: "Please tell me more" before commencing the questioning phase.*

- *(iv) Questioning Phase. […] interviewers were asked to use the information reported by the witness in their free recall phase as a guide for follow-up questions [and] were instructed in the use of appropriate types of questions. They were asked to begin with open questions and then follow these with closed questions. In general interviewers were asked to use the free report to find out who was present at the event and what they did. Where a person was mentioned, interviewers were asked to elicit details about clothing. They were specifically instructed to avoid leading, misleading, and forced-choice questions. The CI interviewers received additional training in the activation and probing of images relating to*

various parts of the event. (For example, the children were told to "picture the magician's face, and then describe it.").".

The aim of the Cognitive Interview is to yield a recall of events as perceived by a witness. It focuses on the *what happened in the world then and there*.

[252] In which case, the same speech clause is "analytically duplicated" and numbered as many times as its semantic analysis yields CogOps.

[253] It may happen that Specch Clauses do not clearly allow to identify the *opening* CogOp of a Present moment or the *closing* Action of the same Present moment. When the cognigraph is drawn these gaps, if not yet detected, appear clearly and this provides the researcher with an opportunity to reflect on his prior semantic analysis of the narrative. This is when some CogOps may be assumed.

[254] A step (speech unit) is a move, a change of perspective within the story, identified by the researcher . Steps are articulated between them by "turns", i.e.,some form of salient event, change in the nature, perspective, focus, mode, or control of the story in progress.

[255] Victim Rescue Vehicle : this is an absolutely free translation, without any reference to an existing type in Britain's emergency services

[256] Without entering into a discussion on differences between needs, drives, and other urges to act.

[257] Defined as "*an inner condition of imbalance (for example, thirst) that provokes an organism to take some remedial action*" (Arnold, 1960)

[258] The subject never narrates his experience chronologically, and Subjective Cueing, by asking him to return to and further detail already evoked Present Moments, generates a natural *fragmentation* of the narration. Speech Clauses relating to one same Present Moment, or even to one same Cognitive Operation, may be found in several answers throughout the transcript of an EI. Sequence tags indicate, for a given speech clause, before which other one it should come chronologically.

[259] "*A process in which the researcher writes down ideas about the evolving theory […]*" : used in grounded-theory research, this technique, I believe, is very well suited for my own research as it is a way to explicit the grounds of my epistemological choices and my own stance, and their variations as my study progressed.

[260] "*Les travaux de Theureau sur le cours d'action, qui sont à la source de notre propre réflexion sur le cours d'événements, reposent sur la notion centrale de "signe tétradique" (objet, interprétant acquis, representamen, unité de cours d'action), elle-même fondée sur la théorie du signe triadique de Peirce (objet, interprétant, representamen). Theureau considère le cours d'action comme "un enchaînement de signes*

tétradiques", "directement alternative à ce que postule la psychologie cognitiviste pour les conduites cognitives" et qui, "par la notion d'objet, place la relation de l'acteur avec le contexte, les circonstances particulières, à la base du cours d'action, de sa dynamique locale". Le concept de representamen "insiste sur le rôle de l'activité perceptive dans le cours d'action ici et maintenant", tandis que le concept d'interprétant acquis renvoie à l'idée de typicalité de Rosch faisant "le lien entre cours d'action ici et maintenant et cours d'action passé". La notion d'unité de cours d'action renvoie à l'idée d'un sentiment d'unité de signification pour l'acteur de ses divers actes. D'un point de vue épistémologique, l'approche de Theureau, assez complexe, un peu confuse au premier abord, repose sur le principe de l'observatoire du cours d'action où l'analyse "en signes" des verbalisations des acteurs permet de mettre à jour l'enchaînement de signes tétradiques. Elle prétend à une représentation formelle du cours d'action au moyen de "graphes d'analyse en structures significatives" et par la "représentation graphique des différentes sortes de signes". Elle propose une taxonomie des éléments du signe tétradique. Elle repose, enfin, sur le "primat de l'intrinsèque", c'est-à-dire sur la recherche du point de vue intérieur des acteurs au travail sur le cours de leur action au moyen de l'analyse "en signes"[260] des verbalisations (au regard des prescriptions "nominales" des processus[260]), et de la pratique de la confrontation et de l'autoconfrontation." (Théron, 2005).

[261] Triadic means excluding the *unity of the course of action, the underlying story that gives sense to triadic transformations of input objects.*

[262] This is how phenomenology came to be a possible way forward in Lieutenant A's case study.

[263] Attempts were made to model mental activities by Lamareille (2009) based on data class models used in UML 2.0, 2004 version. For a more current version of UML, refer to Version 2.4.1 at http://www.omg.org/spec/UML/2.4.1/Infrastructure/PDF.

[264] Course of Events, Course of Action

[265] Cross-coding, i.e., the performance of this semantic elicitation of CogOps should be performed by several researchers.

[266] By convention, from now on by cognitive operation we mean both a "cognitive operation" (perception, thoughts, emotions, etc…) and an "action" or a "state" (doing something, being or standing somewhere, speaking, moving, …).

[267] Sub-type (ST)

[268] This process also helps to verify the taxonomy of CogActs and CogObjs by : making sure that each sub-type of act or object is independent from the others, and by making sure that each sub-type is assigned into the correct more abstract type.

[269] Refer to ANNEX 12 or 13

[270] Refer to the following sub-section for more details on these levels of analysis of DMA patterns.

[271] In the integrated RPD Model. Refer to the chapter on NDM for more details.

[272] It was experimentally engineered, in many steps of progressive refinement through which the data processing method emerged and became more and more formal. If the data model guarantees a certain flexibility in the process, a few inconsistencies appeared and were resolved by creating ad hoc data integrity check functions.

[273] Decision-Making-in-Action

[274] Asymmetric lambda is interpreted as the probable improvement in predicting the column variable Y given knowledge of the row variable X. Asymmetric lambda has the range $0 < \lambda < 1$.

[275] The present thesis is not based upon Wittgenstein's approach of the inner experience.

[276] My own translation

[277] My own translation

[278] "*subjects recalled memory details clustered around the detail they subsequently judged the most distinctive*" (p. 70).

[279] There are a number of variants of these research protocols. It is not my intention to discuss them as they are out of my scope.

[280] In the case of Firemen : *milieu* would be more appropriate

[281] Herman, J. L. (1992). *Trauma and Recovery*. New-York: Basic Books, quoted by Matthews & Chu (1997)

[282] The therapist in (Matthews & Chu, 1997)

[283] EM stands for "Etat-Major" : Headquarters ; G stands for "Groupement" : Group ; then EMG1 stands for "Headquarters of the First Fire Group"

[284] Literally "9th Rescue Company" : a Fire Station.

[285] History and organisation of the Brigade des Sapeurs-Pompiers de Paris :

The Paris Fire Brigade (BSPP : Brigade des Sapeurs-Pompiers de Paris, France) enrolls more than 8000 men these days, amounting to about 3% of all French Fire Forces, and was created as a military unit on September 18th 1811 by Emperor Napoleon the First (then called "Bataillon des Sapeurs-Pompiers de Paris" with a total of four companies and 571 men) after the Austrian Embassy in Paris was devastated by a major fire on July 1st 1810, leaving over a hundred diplomats and their wives dead. Inheriting from a century old tradition of courage and technical improvements, they were made a military unit after it was revealed that the Commanding Officer of the "Garde-Pompe de Paris", the name of the batalion before the fire and since the 1720's, was away in the country when the Austrian embassy fire started and had therefore been unable to command his men. The 19th Century saw the structuring of the BSPP as well as attempts to develop techniques (Gallet, 2006 ; Rolland, 2005) - like clothing and breathing hardware along with different types of ladders - that would allow men to approach fire closer and more safely, to operate for longer periods of time or in hostile atmospheres, and to rescue victims more efficiently. Regulations were passed that defined more and more precisely the Brigade's organisation.

The BSPP's territory

The BSPP's territory includes Paris and the "Départements" immediately surrounding it. It is today placed under the combined authority of the Préfet de Police de Paris (Paris Police Prefect), the Gouverneur Militaire de Paris (Paris Military Governor) and the Maire de Paris (Paris Mayor). The Paris' Police Prefect who is in charge of the Capital's Civil Security commands the Brigade. The Paris Military Governor would coordinate the engagement of military forces with Civil Security forces should a major catastrophe affect the area. As such, the BSPP being a military unit would fall under his command. The Mayor of Paris supports the BSPP financially, just as other local communities in its area of competence. But Paris sheltering so many political, official and diplomatic sites, not mentioning its vast population of about two and a half million people, the Maire de Paris has a stronger connection with the BSPP than any other local community. In total, the area under the protection of the BSPP represents more than six million people, two million workers on transit everyday, twenty-five million tourists every year. It operates 2 300 kilometres of gas piping, 250 kilometres of Métro rail lines, 3 airports (Roissy, Orly and Le Bourget) and three quarters of all the high-rise buildings of France, 365000 companies, 17 oil depots, the largest food market in Europe and, altogether, 25% of the national GNP. That territory also includes the strategic sites of the Presidency, the two Chambers of the Parliement and Senate, along with Central Ministerial administrations, 130 embassies, 5 "Préfectures" and 144 town Halls. Monuments, 105 museum and numerous sites open to the Public plus several thousands kilometres of technical galleries define an area of intervention ranging from 35 metres below ground surface to 310 metres above at the top of the Eiffel Tower.

The BSPP's command chain and structure

Headed by a Three star General and his Etat-Major, the BSPP is divided into three Fire Groups (Groupements Incendie), a Logistics Group (Groupement des Services), a Training Group (Groupement Formation) and three Detachments (Détachements) based on the strategic sites of Kuru (French Guyana, where space launches take place), Lacq (a major Oil & Gas site in the South-West of France) and Biscarosse (a military site in Southern France). Each Fire Group is divided into Fire Companies (Compagnies d'Incendie, 24 in total), themselves divided into Fire Stations (Centres de Secours, literally "Rescue Centres", more commonly call Fire Stations). G1, in particular, has responsibility for a territory including the North of Paris and the Department of *Seine-Saint-Denis* on the North / North-East border of the city. This is the most turbulent and dangerous portion of the BSPP territory, where the number of criminal assaults has increased by up to 24.8% per year (See http://www.cartocrime.net) between 2003 and 2007, not mentioning danger stemming from main and suburban railway lines, tunnels, motorways (A1, A3), industries, depots, decrepited housing, etc... Seine-Saint-Denis is the area where urban riots started in 2005 after a police chase ended-up in two teenagers hiding inside an electric transformer where they died electrocuted. Riots then spread through the whole country for nearly a month. Val de Marne in the East / South-East (Under command of G2) is also a popular area punctuated with industrial sites, main and suburban railway lines, tunnels and motorways (A6). And Hauts-de-Seine in the West / South-West (G3's responsibility) is the poshest area incorporating business areas like "La Défense" just West of the Capital and next to Neuilly and Saint-Cloud, two of the richest local communities in France. This department has also its motorways (A13, A14), long tunnels, railway lines, etc.

Regulation and discipline

BSPP's interventions are framed by strict operational and security regulations (BSP 118: Regulation of the organisation and operation of the firefighting and rescue service, "Réglement sur l'organisation et le fonctionnement du service d'incendie et de secours", of June 2004). Some more specific regulations such as the BSP 370 of March 1995 regarding interventions on railway premises provide more detailed ad hoc instructions. Global intervention plans detail the concepts, rules of engagements and means to dispatch to the field in case major incidents happen. The *Plan Rouge* (Red Plan, 1978, revised in 1989) describes the concept of operations in case of an incident involving massive casualties. The *Plan Rouge Alpha* (Alpha Red Plan, 2005) addresses multi-terrorist attacks, the *Plan Jaune* (Yellow Plan) addresses CBRN attacks, the *Plan Troubles Urbains* (Urban Unrest Plan) organises the BSPP's response in case of riots similar to the 2005 ones, ... Beside, National Reference Guides (GNR) detail instructions to follow when facing specific situations such as the 2003 GNR on Backdraft and Flash-Over.

Discipline is at the heart of BSPP's activities. No one can ignore it as the code of discipline is of mandatory knowledge (BSP 118 – Part 2 (Intervention general duties and roles ; Devoirs généraux et rôles en intervention) – Title 1 – Chapter 2 : Discipline). Discipline[285] is founded on a perfect knowledge and seasoned practice of the job to be performed (ibid). Situations are reckoned to be harsh (hasty departures from the Station, heat, smoke, aggressive - chemical for instance – atmospheres, …). And this is precisely because there are many dangers to expect that regulation BSP 118 excludes any "*hesitation*" and

"*improvisation*" which could result from a lack of discipline, preparation and knowledge (ibid)[285]. Discipline also challenges both the physical and cognitive abilities of Men engaged in fire-fighting who must "*protect themselves, keep a cool mind, operate in silence, keep constantly in touch with a colleague, report immediately*" (ibid)[285]. Firemen accept the terms of that discipline, even at the expense of their own involvement in the active fire-fighting service, for instance if they can't pass their annual physical test of aptitude or have been wounded. A BSPP's common saying is that Firemen's image of Self, their sense of identity is that "A Fireman fights fire".

Education and training

Education plays a crucial part in BSPP Men's life as beside discipline, they have to learn the technicalities of the job. When just enrolled Men start their curriculum with a four months period during which their physical and mental resistance are challenged and the basics of their future job are taught to them. Then, further periods of instruction are mandatory throughout their professional involvement up to the highest ranks of sub-officership, as well as daily exercises and tests at the Fire Station aimed at reinforcing and checking their current ability to perform their tasks. Officers come mostly from High Military Schools and many of them also graduate from Universities. They are trained to command operations and men. Two of their most important training courses are consecutively the "Officier PC" (Command Car Officer) and the "Commandant des Opérations de Secours" (Rescue Operations Commander), which they are to undertake with success in order to manage field operations, the first one preparing Officers to be deputies to Rescue Operations Commanders. These training sessions include further apprenticeship of Tactical Reasoning Methods and of the "Marche Générale des Opérations" (MGO = General Conduct of Operations) which provide the guidelines necessary to sequence any intervention within their remit. Exercises aimed at familiarising men with plans, situations and technical means are frequently organised, based now on a Directive of February 2007. Full scale exercises are run every year under the conduct of the Bureau Formation Instruction (*BFI*, the Training & Instruction Bureau). On one hand, these are mainly an occasion to put to the test the ability of the Rescue Operation Commander in charge, a way for him to repeat procedures he has learned. On the other hand, they are an occasion for every one to understand the part they would take should an incident of the type under test occur. Every one learns from exercises, even young Firemen still in their period of instruction as they are called in to play a part in every exercise. Exercises are systematically concluded with a collective debriefing - not in the psychological sense here - during which the Officer in charge of organising and observing the exercise gives all main actors an opportunity to express the lessons they learned. This includes "Agencies" external to the BSPP but who would normally take part in real operations and who are invited to play it during the exercise (SAMU for instance, the Medical Emergency Service). "RETEX" (literally "Return on Experience", Lesson Learning) is the link between performed interventions and the establishment of new regulations and training courses. It is regulated by a "Note" of February 2005 that stipulates its aims and principles. If the "individual experience" of men involved is at the heart of preoccupations mentioned in the text, in practice, RETEX is rather formal, takes an "expert stance" and analyses fire propagation and the way it was prevented or handled, the way the line of command functioned and the involvement of the medical component of the BSPP interventions.

Rituals, death and good fires

The life of the Fire Station is paced by different ritual activities. At 8AM, in all Stations, men gather in the courtyard and that's the beginning of their day. They are reminded operational instructions and prospective events, while their colleagues on duty during the past twenty-four hours finish their shift. 8AM is then also the time duty shifts start and finish and they last for a period of twenty-four hours up to seventy-two hours. BSPP's motto, "*Sauver ou Périr*" (*Rescue or Perish*), is a pillar of its doctrine. Victim rescue is at the forefront of its priorities and its culture has been shaped by a myth of heroism formed in 1868 (Rolland, 2005), when "Sapeur" Thibault armed only with a ladder and his courage rescued several people screaming through their windows while fire was raging behind them, the story says. The Brigade's motto, according to Didier Rolland, the historian and an experienced Major (Major is the highest rank amongst Sub-Officers. It is accessed through a concours open to Adjudants-Chefs) of the Brigade in his fifties, means "*I will go to the end of my physical possibilities in order to rescue a victim, and it means giving my life up to succeed, I will sacrifice my body to that end*". For him, the BSPP's culture is one of duty to rescue victims, of cohesive vigilant team, of "going beyond one's own corporality", of uncompromising mandatory excellence, of effort and training, of discipline and organisation, and of ritual reinforcements of that culture. Once a month, a special gathering of all available men is organised : that's the "*Appel des Morts*", the roll call of the dead. The names of Firemen killed on duty are called, one after the other, and someone is assigned the task of replying "*present*" for them. Dead Firemen are therefore always present in the Brigade's daily routine. People talk of them as if they were virtually there, they set a daily example for every one, like a landmark in good fire-fighting practice or like an active reminder of the dangers and risks of their activities. Death is said by Men to be a deeply thought of issue, a tragic possibility, a living enemy who fills Men's thoughts as they are moving to fight a fire and triggers their sense of responsibility and discipline. The level of the demands placed on the Men is said to be high but they are excited at the prospect of going for a "*bon feu*", a "*good fire*" as they say, one that is hard to understand, contain and extinguish, which you have to fight like "*a living creature*" in their own words. Typically, when you meet any Fireman and ask "*How are you* ?", invariably they will answer "*Very well, thank you, we had some good fires...*". A "good fire" is THE challenge, the ultimate fascination and reason why they do this job, Firemen's attitude being quasi-promethean, like an irresistible invitation to take control of Fire itself.

Duty shifts

Duty shifts range from 24 to 72 hours, 72 hours shifts being extremely wearing. They start and finish at 8AM. Every day, all engines are assigned a team on duty shift, in particular on VSAV vehicles (Véhicule de Secours Aux Victimes), an emergency vehicle only equipped for light paramedics interventions and run by four Men, and on PS vehicles (Premiers Secours Evacuation) engine, a multipurpose emergency vehicle equipped both for light paramedics and fire-fighting emergency interventions. It embarks five Men with sets of hoses, a water capacity of 600 Litres, and a light deployable ladder on its roof. The VSAV is the most solicited vehicle. The CS9 Station has two of them, respectively VSAV1 (the first to go if available) and VSAV2. VSAV1 operates an average number of interventions of 20 to 25 per 24 hours. Being on a shift

means 24 hour availability to go down to business. Whether you are in the middle of your lunch, or slipping fast at the Station, or else, when the alarm rings for you, you have merely a minute to get up on your feet, to get fully dressed, collect instructions from the switchboard and to get into the car. On average, a rescue mission, all inclusive, takes between 40 and 60 minutes. At the G1's Headquarters, I was also allowed to follow Officers on duty should a fire or any other kind of emergency operation take place that he would have to command. This is how I could experience the friction with Police forces[285] that is common in the field as fire fighters and policemen have different concepts of operation and different modes of command, with minimal coordination between them.

The General Conduct of Operations

One of the most noticeable folds of the COS course (which I took in September – October 2007) has to do with the MGO ("*Marche Générale des Opérations*"), the General Conduct of Operations that specifies the successive stages of any intervention on a fire. Reconnaissance consists to explore all places exposed to the fire in order to be able to proceed immediately to the search for and rescue of possible victims and to find out the nature, localisation and extent of the fire, the appropriate mode of extinction, the most suitable points of attack and its potential for propagation, therefore the limits the fire should not overpass. It also serves to take immediate actions to contain the fire, to help the evacuation of hot gases and to prevent accidents and mistakes. Rescue consists to substract people from danger, whether it is real or they only fear they might be exposed. Setting-up (hose lines) consists in deploying and securing hoses dispensing water or mousse as appropriate to the situation. Ventilation consists in forcing air circulation in order to push hot gases and fumes out of the premises so as to secure and facilitate the progression of Firemen and to ease the extinction of the fire. Attack consists to attack the fire with appropriate extinguishing means, water, mousse or otherwise, that have been established before. It aims at reducing flames until they are pulled out and to stop the propagation of the fire. Protection aims at limiting the damage that can be caused by fire, water, heat and smoke. Cleaning and stripping facilitate the complete extinction of the fire and consist to remove contents and containers debris that may restart the fire or keep it active for a longer period of time. Surveillance consists to watch the premises after the fire has been pulled out in order to prevent or to stop immediately any resurgence. The MGO's process is extended, de facto, to all other, non fire extinguishing, interventions. MGO is the result of the BSPP's experience and is said to be very useful to prevent accidents and to ease-up fire-fighting operations.Among the BSPP senior Reservists, stands Lieutenant-Colonel René Dosne, a man whose particular talent is that along forty years of service he has devised a technique of drawing fire propagation and he has an amazing knowledge of the phenomenon. Based on an analysis of vertical and horizontal volumes, he helps Rescue Operation Commanders to articulate very quickly a fire-fighting strategy. All examples of his drawings also show the pedagogic interest of René Dosne's numerous accounts of fires he worked on. He has edited them in many BSPP's magazine "*Allo 18*" articles and has detailed them during many training sessions. The lessons from his work impregnate the BSPP's strategy of action on an everyday basis. All Men know about him and his technique has helped to reduce the risk of accidents. His research has been one of the foundations of the development of "Ventilation".

How BSPP Firemen operate and make on-scene decisions

In field settings, Firemen both plan their intervention and make instant decisions to process situations at hand. In fire-fighting settings, situations at hand are constantly evolving, sometimes quickly and roughly, always uncertain and dangerous. They require expertise, physical strength, psychological balance and moral commitments that may extend as far as dying to rescue victims ("*Sauver ou Périr*" is BSPP's motto). Sometimes, especially when there are risks of an explosion or of fire propagation, time-pressure and care rule Firemen's actions, which, according to regulation, must always be targetted, thought-of, neatly executed, and swift. Moves taken have always the potential to bring men across unexpected hidden sources of danger like still-active electric wire. Goals are well set from the early stages of an intervention : "*La guerre se gagne dans les vingt premières minutes*" ("*War is won in the first twenty minutes*"), Firemen say. Following the prescriptions of the General Conduct of Operations, reconnaissance is performed in the earliest moments of action, tactical decisions are made early and specific tasks are assigned to specific teams of two (Binoms : for instance, the "*Chef d'Attaque*", Chief of Attack, extinguishes, attacks, the fire using the hose while his "*Servant*" helps him first by lifting and moving the hose as needed – hoses in pressure are very rigid, heavy and very physical to handle –, secondly by looking after him and watching surrounding premises for danger, thirdly by being there to extract the Chef d'Attaque should he be injured. Of course there are binoms who do not penetrate the premises to attack the fire from inside. Some are operating ladders, for instance, but the same principles apply. They work as an inseparable team of two, one looking after the other, helping and warning him of dangers, and being there to rescue him if needed. It can be said that Firemen know what they have to do in the field. They are never pursuing unclear or undefined goals. But they face impending risk. In victim-rescue settings, things are significantly different. Teams on a VSAV are under the command of a Chef d'Agrès (Engine Chief). When arriving at the scene of the rescue, they generally discover a victim, and must evaluate her condition in the first moments of their arrival at the scene. Each man, duly qualified, knows what he has to do and does it. Few words are exchanged between team members. When the victim's condition is uncertain, the Chief phones the Medical Co-ordination to get further instructions or advice, and orders or instructions so given are executed. Goals are virtually always cristal clear. Well learned and exercised diagnosis and action routines are the essence of the job at hand. Uncertainty arises when there are people around Firemen Squads, members of the public who are curious, sometimes aggressive, often difficult to control. In such a case, Firemen may call for the assistance of the Police, which they do not necessarily get, or not quickly enough. Which sometimes they get but they wish they would not have, as when the Police are with them on Council Estates social tensions are such that the presence of Police Officers may trigger violence in which Firemen are caught. Many of these interventions take place within people's private habitat. There, domestic violence, alcoholism, mental health problems are quite common and a source of further dangers and uncertainty.

[286] Resequenced speech clause numbers : "8-5-ZZZZZ-ZZZZZ " means that the number is the original speech clause number while "8-10-356-1" is the new resequenced number "8-10" followed by its original counterpart "356-1". This is a processing convention within the Phenomenographic database.

[287] Long-Term Memory / Episodic Memory / Autobiographical Memory

[288] Self here must not be misinterpreted : it designates the acting-self, self as actor performing actions (CogObjST)

[289] Our immersion in the field gave helped the semantic analysis of utterances sometimes difficult to decypher.

[290] Let us remember here that CogActs belong either in a cognitive class or in an action class. What speech clauses elicit first is usually a cognitive act as in "*I see that woman lying on a sofa*". This is generally due to the presence of an action verb.

[291] CogActST / CogAct sub-type

[292] Cognigraphs are produced on the basis of all CogOps, both CERTAIN and ASSUMED.

[293] The first three types of objects in this list share nearly the same sub-types. For instance, "SLF02-STANCE - Lying down / Sitting" is a CogObjST associated with the "SELF" CogObj : it allows the researcher to encode the "what is perceived of himself by the subject" (if "PERCEIVING" is the associated CogAct, possibly through a "PER16- Proprioceptin (have a proprioception = body position/configuration awareness)" CogActST).

[294] The CogOp, PM and EP data sets are supplied separately, as a complement to the present thesis report.

The EP data set supplies data describing each CI Experience Phase (EP).

The PM data set supplies data describing each Present Moment (PM).

The CogOp data set supplies data describing cognitive operations (CogOp). Note that Decision-Making Steps (DM Step) are substituted to CogOp. Note that the CogOp data set is created to analyse the phenotypic links between successive CogOps (⇔ DM Steps).

[295] Driving is said for the most frequent trajectory, alternative for the second most frequent one if any.

[296] PM # 00 was not considered in this analysis as it is only a starting point, the action from which the story departs.

[297] $\chi 2 = \Sigma(o-e)^2/e$, the chi-square of a variable (Y) and an attribute (X) , is the sum of the squared difference between observed (o) and expected (e) values of Y (or deviation, d), divided by the expected

values of Y, in all possible categories of X. Given the values of $\chi 2$ and df (degree of freedom), the p-value determines a probability of independence (if $p \geq 0.05$) between the variable and the attribute. Beyond $p \geq 0.10$ results are not significant. If the calculated p value is $p < 0.05$, the hypothesis of independence is rejected, meaning that some factor other than chance is operating for the deviation to be so great (⇔ DEPENDENCE). For example, a p-value of 0.01 means that there is only a 1% chance that this deviation is due to chance alone. Therefore, other factors must be involved.

[298] Cramer's (1946) *v* varies from 0 (no association) to 1 (association) and measures the inter-correlation of two discrete nominal or ordinal attributes. It is a symmetrical measure that does not consider which attribute is X or Y. it does not take account of the order of rows and columns in the data set. Its limit is that as chi-squared values tend to increase along with the number of rows and columns, the more likely Cramer's *v* tends toward 1, then not providing evidence of a dependence between attributes.

[299] Using the Genie 2.0 free software developed by the Decision Systems Laboratory at Pittsburgh University : http://dsl.sis.pitt.edu/

[300] This analysis was performed with the help of the TANAGRA software, version 1.4.41, developed by Eric Rakotomalala of Lyon 2 University (rakotoma@univ-lyon2.fr). Decision Tree learning algorithms split a data set into nodes and leaves to produce a classification of data into a hierarchical thesaurus, thus partitioning the data set into different homogenous "regions" in which data belong. Splitting is based upon a recursive search for the best categorising attributes and a minimal error. The Random Forest algorithm uses a particular classification technique called bootstrapping that consists in creating reference learning sets on a random basis. Learners are used to grow classification trees. Nodes are split into leaves according to refined learning subsets called predictors. The construction of the tree stops when the error rate stops decreasing. If Random Forest is supposed to lower the error rate over classic decision tree algorithms, it must be noted that in the present case there was no significant difference in the error rates between the C4.5 and Random Forest calculations for a given data set.

[301] C4.5 did not detail the EMOTION in [s6_neutral] condition.

[302] This clause means : DMAPATTERN = **DB_NA** occurs in 100 % of 3 PMs for which THREAT = [s4_SOPmistake]

[303] In lieutenant A's case

[304] Up to 8 steps were thus identified in any cognitive trajectory

[305] A slightly different vocabulary was used originally here. Correspondences with CogAct Families such as described in the taxonomy are: Interpretation = Understanding, Planning = elaborating (a plan of action), LTM = solliciting LTM. These data are not included in the PM data set.

[306] Trait – Attitude – Mood – Emotion cognitive software architecture for creating affect-realistic robots.

[307] Given two classifications of a population, X and Y, with X and Y neither continuous nor ordinal and the X classification of the population preceeding the Y classification either chronologically, causally or otherwise, in guessing the largest marginal proportion of Y (Pym) given the largest proportion of X (Px), i.e. the most likely value of Y given the most frequent value of X, Goodman & Kruskal's (1954) λ measures the association of Y with X in terms of the relative decrease in probability of error in guessing Yi as between Xi unknown and Xi known : "*To put this another way, λy gives the proportion of errors that can be eliminated by taking account of the knowledge of the X classification of individuals*" (Goodman & Kruskal, 1954, p. 741).

[308] The following DM Step production rules were found with the C4.5 algorithm :

Cleaned Rules
· Geno_DM in [DM60- Action]
· Pheno_Attention in [Arousing]
· Pheno_Temp in [Present] then Pheno_DM = DM10- Acquisition (90,91 % of 22 examples)
· Pheno_Temp in [Past] then Pheno_DM = DM01- Attention & STM (60,00 % of 5 examples)
· Pheno_Attention in [Diffusing]
· Pheno_Agency in [Safety] then Pheno_DM = DM10- Acquisition (100,00 % of 4 examples)
· Pheno_Agency in [Control] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
· Pheno_Agency in [Manœuvre]
· Pheno_Focus in [05 Dogs - Threats] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)
· Pheno_Focus in [01 Priority to find missing dog - Duty & Intervention] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 2 examples)
· Pheno_Attention in [Focalising]
· Pheno_Focus in [04 Police Crew - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
· Pheno_Focus in [07 Shootings & Attack - Traumatic experience] then Pheno_DM = DM01- Attention & STM (100,00 % of 3 examples)
· Pheno_Focus in [07 Explanation / Analysis of the events - Explanations]
· Geno_Focus in [07 Explanation / Analysis of the events - Explanations] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
· Pheno_Focus in [07 Gun charger - Explanations] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
· Pheno_Attention in [Saturating] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
· Geno_DM in [DM10- Acquisition]
· Pheno_Temp in [Present]
· Pheno_Focus in [04 BSPP Staff (any) - Rescue Force]
· Pheno_Agency in [Safety] then Pheno_DM = DM10- Acquisition (100,00 % of 5 examples)
· Pheno_Agency in [Manœuvre] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
· Pheno_Focus in [03 Victims - Victims]
· Geno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
· Geno_Focus in [03 Baby - Peripheral actors] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
· Pheno_Focus in [01 Duty & Intervention - Duty & Intervention]
· Pheno_SUBGOAL in [01- Save/Optimise efforts/resources/time] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
· Pheno_SUBGOAL in [02- Fulfil duty/Complete the job at hand] then Pheno_DM = DM27- Judgement (100,00 % of 2 examples)
· Pheno_Focus in [01 Characteristics of case / intervention - Duty & Intervention] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

- · Pheno_Focus in [01 Decisions & Orders - Duty & Intervention] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [01 Regulation & Ethics - Rules]
  - · Pheno_SUBGOAL in [02- Fulfil duty/Complete the job at hand] then Pheno_DM = DM27- Judgement (100,00 % of 2 examples)
  - · Pheno_SUBGOAL in [11- Maintain moral standards] then Pheno_DM = DM03- LTM (100,00 % of 1 examples)
- · Pheno_Focus in [04 Animal Squad – Rescue Force]
  - · Pheno_Attention in [Arousing] then Pheno_DM = DM10- Acquisition (100,00 % of 4 examples)
  - · Pheno_Attention in [Diffusing]
    - · Pheno_Valence in [Satisfactory]
      - · Geno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
      - · Geno_Focus in [04 Animal Squad - Rescue Force]
        - · Pheno_EMOTION in [s6_emotionlessness] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
        - · Pheno_EMOTION in [s4_Mild_AnxietyEtc] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
    - · Pheno_Valence in [Burdensome] then Pheno_DM = DM10- Acquisition (50,00 % of 2 examples)
    - · Pheno_Valence in [Unpleasant] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
- · Pheno_Focus in [04 BSPP PSR - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [06 People present Outside - Stressors]
  - · Geno_Focus in [06 People present Outside - Stressors] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
  - · Geno_Focus in [03 Victims' destination – Victims] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [04 Police Crew - Rescue Force] then Pheno_DM = DM10- Acquisition (84,62 % of 13 examples)
- · Pheno_Focus in [02 Seriousness of the case - Safety] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [06 Parking space in the garden - Settings (World of the intervention)]
  - · Geno_Focus in [06 Parking space in the garden - Settings (World of the intervention)] then Pheno_DM = DM27- Judgement (100,00 % of 2 examples)
  - · Geno_Focus in [06 Main gate - Settings (World of the intervention)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [06 Main gate - Settings (World of the intervention)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [06 Fence - Settings (World of the intervention)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [06 Garden - Settings (World of the attack)] then Pheno_DM = DM10- Acquisition (100,00 % of 3 examples)
- · Pheno_Focus in [04 Medics - Rescue Force]
  - · Pheno_Valence in [Satisfactory] then Pheno_DM = DM10- Acquisition (80,00 % of 5 examples)
  - · Pheno_Valence in [Unpleasant] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [03 Victims' yelling / crying - Stressors] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [03 Lounge in shambles - Stressors] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [03 Sofa - Settings (World of the victims)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [03 Daughter - Victims] then Pheno_DM = DM10- Acquisition (75,00 % of 4 examples)
- · Pheno_Focus in [03 Daughter yelling / begging for anaesthesia - Victims] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [03 Mother - Victims] then Pheno_DM = DM10- Acquisition (60,00 % of 5 examples)
- · Pheno_Focus in [03 Daughter's pain – Stressors] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

- · Pheno_Focus in [07 Lived Experience – Traumatic experience] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [03 Daughter's hair / head - Stressors] then Pheno_DM = DM10- Acquisition (50,00 % of 2 examples)
- · Pheno_Focus in [03 Daughter's condition - Victims] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [05 Dogs - Threats]
  - · Geno_Ctrl in [With RSK] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
  - · Geno_Ctrl in [Reliance]
    - · Pheno_Attention in [Arousing]
      - · Pheno_Valence in [Satisfactory] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
      - · Pheno_Valence in [Unpleasant] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
    - · Pheno_Attention in [Diffusing] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
    - · Pheno_Attention in [Saturating] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
  - · Geno_Ctrl in [Powerlessness] then Pheno_DM = DM10- Acquisition (50,00 % of 2 examples)
  - · Geno_Ctrl in [Vigilance] then Pheno_DM = DM10- Acquisition (100,00 % of 5 examples)
- · Pheno_Focus in [01 Priority to find missing dog - Duty & Intervention] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Pheno_Focus in [06 Trees & Groves - Settings (World of the search)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [02 Danger & Risks - Safety] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
- · Pheno_Focus in [05 Father – Threats] then Pheno_DM = DM10- Acquisition (91,67 % of 12 examples)
- · Pheno_Focus in [07 Shootings - Traumatic experience] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
- · Pheno_Focus in [07 14th July Fireworks - Stereotypes] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [07 Shootings & Attack - Traumatic experience] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Pheno_Focus in [07 Lt A's own motion - Traumatic experience] then Pheno_DM = DM33- Coping (100,00 % of 1 examples)
- · Pheno_Focus in [07 Police shooting at dogs - Traumatic experience] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [06 A car parked in the garden - Settings (World of the intervention)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [06 Shade in adjacent parcel - Settings (World of the search)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [07 Failing to find the missing dog - Stressors]
  - · Geno_Focus in [04 Animal Squad - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
  - · Geno_Focus in [07 Failing to find the missing dog - Stressors] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [07 Succeeding to find the missing dog - Safety] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [04 Veterinary - Rescue Force]
  - · Geno_Focus in [04 Animal Squad - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
  - · Geno_Focus in [04 Veterinary - Rescue Force] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Pheno_Focus in [07 Explanation / Analysis of the events - Explanations]
  - · Geno_Focus in [07 Explanation / Analysis of the events - Explanations] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
  - · Geno_Focus in [07 Gun charger - Explanations] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [07 Gun charger - Explanations] then Pheno_DM = DM03- LTM (100,00 % of 1 examples)
- · Pheno_Focus in [04 Forensics team - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [04 Forensics' envelops - Rescue Force]

- · Geno_Focus in [04 Forensics team - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Geno_Focus in [04 Forensics' envelops - Rescue Force] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Focus in [04 Forensics' equipment - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)

· Pheno_Focus in [04 Forensics methods - Rescue Force] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Focus in [02 Search for casualties in neighbouring villas - Safety]

- · Geno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Geno_Focus in [02 Search for casualties in neighbouring villas - Safety] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Focus in [04 SAMU ambulance - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 3 examples)

· Pheno_Focus in [04 SAMU ambulance initiative - Rescue Force] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Temp in [Past]

· Pheno_Focus in [01 Characteristics of case / intervention - Duty & Intervention] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Focus in [01 Regulation & Ethics - Rules] then Pheno_DM = DM03- LTM (100,00 % of 1 examples)

· Pheno_Focus in [03 Hair on table - Stressors] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)

· Pheno_Focus in [05 Dogs - Threats] then Pheno_DM = DM27- Judgement (100,00 % of 4 examples)

· Pheno_Focus in [07 Shootings & Attack - Traumatic experience] then Pheno_DM = DM01- Attention & STM (75,00 % of 4 examples)

· Pheno_Focus in [07 Police shooting at dogs - Traumatic experience] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)

· Pheno_Focus in [07 Explanation / Analysis of the events - Explanations]

- · Geno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Geno_Focus in [07 Explanation / Analysis of the events - Explanations] then Pheno_DM = DM21- Analysis (100,00 % of 2 examples)
- · Geno_Focus in [07 Gun charger - Explanations] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)

· Pheno_Focus in [04 SAMU ambulance - Rescue Force] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)

· Pheno_Temp in [Future]

· Geno_Focus in [04 Police Crew - Rescue Force] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)

· Geno_Focus in [05 Dogs - Threats] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)

· Geno_Focus in [04 Forensics' equipment - Rescue Force] then Pheno_DM = DM27- Judgement (100,00 % of 2 examples)

· Geno_DM in [DM27- Judgement]

· Pheno_Temp in [Present]

· Pheno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM44- Orientation (Action Design) (100,00 % of 1 examples)

· Pheno_Focus in [01 Duty & Intervention - Duty & Intervention]

- · Pheno_SUBGOAL in [02- Fulfil duty/Complete the job at hand] then Pheno_DM = DM50- Selection (100,00 % of 2 examples)
- · Pheno_SUBGOAL in [03- Protect others / Secure] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Focus in [01 Characteristics of case / intervention - Duty & Intervention] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)

· Pheno_Focus in [01 Decisions & Orders - Duty & Intervention]

- · Geno_Focus in [01 Duty & Intervention - Duty & Intervention] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Geno_Focus in [01 Decisions & Orders - Duty & Intervention] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)

· Pheno_Focus in [04 Animal Squad - Rescue Force]

- · Pheno_Valence in [Satisfactory] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Valence in [Unpleasant] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)

- · Pheno_Focus in [04 BSPP PSR - Rescue Force]
  - · Geno_Focus in [01 Decisions & Orders - Duty & Intervention] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
  - · Geno_Focus in [06 People present Outside - Stressors] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [06 People present Outside - Stressors] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Pheno_Focus in [04 Police Crew - Rescue Force] then Pheno_DM = DM33- Coping (100,00 % of 1 examples)
- · Pheno_Focus in [06 Parking space in the garden - Settings (World of the intervention)]
  - · Geno_Focus in [02 Seriousness of the case - Safety] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
  - · Geno_Focus in [06 Parking space in the garden - Settings (World of the intervention)] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [06 Main gate - Settings (World of the intervention)] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [04 Medics - Rescue Force]
  - · Pheno_Attention in [Arousing] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
  - · Pheno_Attention in [Diffusing] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
  - · Pheno_Attention in [Lowering] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Focus in [03 Daughter - Victims] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [03 Daughter yelling / begging for anaesthesia - Victims] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [07 Lived Experience - Traumatic experience] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
- · Pheno_Focus in [03 Daughter's wounds - Stressors] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)
- · Pheno_Focus in [03 Daughter's condition - Victims]
  - · Geno_Focus in [01 Regulation & Ethics - Rules] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
  - · Geno_Focus in [03 Daughter's condition - Victims] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
- · Pheno_Focus in [03 Baby - Peripheral actors] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [05 Dogs - Threats]
  - · Pheno_Valence in [Satisfactory] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
  - · Pheno_Valence in [Unpleasant] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
  - · Pheno_Valence in [Harmful] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [01 Reporting message - Duty & Intervention] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [02 Danger & Risks - Safety] then Pheno_DM = DM31- Appraisal (100,00 % of 5 examples)
- · Pheno_Focus in [07 Shootings & Attack - Traumatic experience]
  - · Pheno_SUBGOAL in [03- Protect others / Secure] then Pheno_DM = DM02- Metacognition (100,00 % of 1 examples)
  - · Pheno_SUBGOAL in [04- Protect oneself] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
  - · Pheno_SUBGOAL in [06- Get relief / De-stress / Vent emotions] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
  - · Pheno_SUBGOAL in [10- Be sociable] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [07 Police shooting at dogs - Traumatic experience] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
- · Pheno_Focus in [07 Failing to find the missing dog - Stressors] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
- · Pheno_Focus in [07 Succeeding to find the missing dog - Safety] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [07 The truth about the events - Explanations] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)

- · Pheno_Focus in [07 Like a machine gun - Stereotypes] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [07 Explanation / Analysis of the events - Explanations] then Pheno_DM = DM31- Appraisal (80,00 % of 5 examples)
- · Pheno_Focus in [07 Gun charger - Explanations] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
- · Pheno_Focus in [04 Forensics' envelops - Rescue Force] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Pheno_Focus in [04 Forensics' equipment - Rescue Force] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [04 Forensics difficult job - Rescue Force] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
- · Pheno_Focus in [01 Intervention's proper end - Duty & Intervention] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Pheno_Focus in [03 Victims' destination - Victims] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
- · Pheno_Focus in [02 Search for casualties in neighbouring villas - Safety] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [06 TV Crew - Stressors] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Focus in [07 Righteousness of the shooting - Explanations] then Pheno_DM = DM02- Metacognition (100,00 % of 1 examples)

· Pheno_Temp in [Past] then Pheno_DM = DM03- LTM (100,00 % of 3 examples)

· Pheno_Temp in [Future] then Pheno_DM = DM27- Judgement (66,67 % of 3 examples)

· Geno_DM in [DM21- Analysis]

· Pheno_Temp in [Present]

· Pheno_Mean_EMOTION in [s4_LittleNegative]

· Pheno_Focus in [03 Victims - Victims] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)

· Pheno_Focus in [01 Duty & Intervention - Duty & Intervention] then Pheno_DM = DM48- Checking (consistency / applicability / efficiency / outcome) (100,00 % of 1 examples)

· Pheno_Mean_EMOTION in [s3_FairNegative]

· Pheno_Attention in [Diffusing] then Pheno_DM = DM27- Judgement (66,67 % of 3 examples)

· Pheno_Attention in [Focalising] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)

· Pheno_Mean_EMOTION in [s2_MildNegative]

· Pheno_Valence in [Unpleasant] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)

· Pheno_Valence in [Distressing]

· Pheno_SUBGOAL in [03- Protect others / Secure] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_SUBGOAL in [06- Get relief / De-stress / Vent emotions]

· Pheno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)

· Pheno_Focus in [07 Shootings & Attack - Traumatic experience] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_SUBGOAL in [08- Understanding / Interpreting] then Pheno_DM = DM27- Judgement (100,00 % of 2 examples)

· Pheno_Valence in [Critical or Fatal] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Mean_EMOTION in [s1_SignificantNegative] then Pheno_DM = DM02- Metacognition (66,67 % of 3 examples)

· Pheno_Temp in [Past]

· Pheno_Valence in [Satisfactory] then Pheno_DM = DM03- LTM (100,00 % of 2 examples)

· Pheno_Valence in [Unpleasant] then Pheno_DM = DM10- Acquisition (50,00 % of 2 examples)

· Pheno_Valence in [Distressing] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)

· Pheno_Temp in [Future]

· Pheno_Valence in [Burdensome] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Pheno_Valence in [Distressing] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)

· Pheno_Valence in [Harmful] then Pheno_DM = DM22- Anticipation (SA) (100,00 % of 1 examples)

· Geno_DM in [DM03- LTM]

· Pheno_Mean_EMOTION in [s4_LittleNegative]

· Pheno_Focus in [03 Victims - Victims] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)

- · Pheno_Focus in [01 Duty & Intervention - Duty & Intervention]
  - · Geno_Focus in [01 Duty & Intervention - Duty & Intervention] then Pheno_DM = DM22- Anticipation (SA) (100,00 % of 1 examples)
  - · Geno_Focus in [01 Regulation & Ethics - Rules] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
- · Pheno_Mean_EMOTION in [s3_FairNegative]
  - · Pheno_Focus in [01 Duty & Intervention - Duty & Intervention] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
  - · Pheno_Focus in [04 LtA's Car - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Pheno_Mean_EMOTION in [s2_MildNegative]
  - · Pheno_Agency in [Safety]
    - · Pheno_Attention in [Arousing] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
    - · Pheno_Attention in [Diffusing]
      - · Pheno_Temp in [Present] then Pheno_DM = DM27- Judgement (80,00 % of 5 examples)
      - · Pheno_Temp in [Past] then Pheno_DM = DM03- LTM (100,00 % of 1 examples)
    - · Pheno_Attention in [Focalising] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
  - · Pheno_Agency in [Manœuvre] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)

· Geno_DM in [DM22- Anticipation (SA)]

- · Pheno_Focus in [01 Decisions & Orders - Duty & Intervention] then Pheno_DM = DM44- Orientation (Action Design) (100,00 % of 1 examples)
- · Pheno_Focus in [07 Police shooting at dogs - Traumatic experience] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Geno_DM in [DM44- Orientation (Action Design)] then Pheno_DM = DM50- Selection (75,00 % of 4 examples)

· Geno_DM in [DM48- Checking (consistency / applicability / efficiency / outcome)]

- · Pheno_Focus in [01 Duty & Intervention - Duty & Intervention] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_Focus in [01 Regulation & Ethics - Rules]
  - · Pheno_Temp in [Present] then Pheno_DM = DM48- Checking (consistency / applicability / efficiency / outcome) (100,00 % of 1 examples)
  - · Pheno_Temp in [Future] then Pheno_DM = DM44- Orientation (Action Design) (100,00 % of 1 examples)

· Geno_DM in [DM50- Selection] then Pheno_DM = DM60- Action (100,00 % of 29 examples)

· Geno_DM in [DM31- Appraisal] then Pheno_DM = DM32- Affection / Shock (100,00 % of 21 examples)

· Geno_DM in [DM32- Affection / Shock]

- · Pheno_Mean_EMOTION in [s4_LittleNegative] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)
- · Pheno_Mean_EMOTION in [s3_FairNegative] then Pheno_DM = DM33- Coping (100,00 % of 4 examples)
- · Pheno_Mean_EMOTION in [s2_MildNegative]
  - · Geno_Ctrl in [With RSK] then Pheno_DM = DM33- Coping (100,00 % of 10 examples)
  - · Geno_Ctrl in [Powerlessness]
    - · Pheno_Focus in [07 Shootings - Traumatic experience] then Pheno_DM = DM32- Affection / Shock (100,00 % of 1 examples)
    - · Pheno_Focus in [07 Lt A's perimeter & proximate people - Traumatic experience] then Pheno_DM = DM33- Coping (100,00 % of 1 examples)
  - · Geno_Ctrl in [Vigilance] then Pheno_DM = DM33- Coping (100,00 % of 1 examples)
- · Pheno_Mean_EMOTION in [s1_SignificantNegative] then Pheno_DM = DM33- Coping (100,00 % of 4 examples)

· Geno_DM in [DM01- Attention & STM]

- · Pheno_Temp in [Present]
  - · Pheno_SUBGOAL in [02- Fulfil duty/Complete the job at hand] then Pheno_DM = DM10- Acquisition (100,00 % of 4 examples)
  - · Pheno_SUBGOAL in [03- Protect others / Secure] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)
  - · Pheno_SUBGOAL in [04- Protect oneself]
    - · Pheno_Focus in [04 Police Crew - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
    - · Pheno_Focus in [05 Dogs - Threats] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
  - · Pheno_SUBGOAL in [06- Get relief / De-stress / Vent emotions] then Pheno_DM = DM27- Judgement (66,67 % of 3 examples)

- · Pheno_SUBGOAL in [08- Understanding / Interpreting] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_SUBGOAL in [10- Be sociable] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
- · Pheno_SUBGOAL in [11- Maintain moral standards]
  - · Pheno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
  - · Pheno_Focus in [01 Decisions & Orders - Duty & Intervention] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
- · Pheno_Temp in [Past]
  - · Pheno_SUBGOAL in [02- Fulfil duty/Complete the job at hand] then Pheno_DM = DM27- Judgement (100,00 % of 2 examples)
  - · Pheno_SUBGOAL in [03- Protect others / Secure] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
  - · Pheno_SUBGOAL in [06- Get relief / De-stress / Vent emotions] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
  - · Pheno_SUBGOAL in [08- Understanding / Interpreting] then Pheno_DM = DM21- Analysis (100,00 % of 2 examples)
  - · Pheno_SUBGOAL in [10- Be sociable] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)

· Geno_DM in [DM33- Coping]

- · Geno_Ctrl in [With RSK]
  - · Pheno_Mean_EMOTION in [s3_FairNegative] then Pheno_DM = DM27- Judgement (100,00 % of 1 examples)
  - · Pheno_Mean_EMOTION in [s2_MildNegative]
    - · Pheno_Attention in [Arousing]
      - · Pheno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM60- Action (100,00 % of 1 examples)
      - · Pheno_Focus in [04 Forensics team - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
    - · Pheno_Attention in [Diffusing] then Pheno_DM = DM60- Action (100,00 % of 1 examples)
    - · Pheno_Attention in [Focalising] then Pheno_DM = DM60- Action (100,00 % of 7 examples)
  - · Pheno_Mean_EMOTION in [s1_SignificantNegative] then Pheno_DM = DM60- Action (100,00 % of 4 examples)
- · Geno_Ctrl in [Reliance] then Pheno_DM = DM60- Action (100,00 % of 1 examples)
- · Geno_Ctrl in [Distraction] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
- · Geno_Ctrl in [Struggling] then Pheno_DM = DM60- Action (100,00 % of 1 examples)
- · Geno_Ctrl in [Powerlessness] then Pheno_DM = DM33- Coping (100,00 % of 3 examples)
- · Geno_Ctrl in [Vigilance]
  - · Geno_Focus in [05 Dogs - Threats]
    - · Pheno_EMOTION in [s2_fear] then Pheno_DM = DM33- Coping (100,00 % of 1 examples)
    - · Pheno_EMOTION in [s1_trauma] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
  - · Geno_Focus in [07 Bullets in motion - Traumatic experience] then Pheno_DM = DM33- Coping (100,00 % of 1 examples)
- · Geno_Ctrl in [Margins seeking]
  - · Pheno_Focus in [04 Police Crew - Rescue Force] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)
  - · Pheno_Focus in [07 Lt A's own sensation of pain - Traumatic experience] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
  - · Pheno_Focus in [07 Bullets in motion - Traumatic experience] then Pheno_DM = DM33- Coping (100,00 % of 1 examples)
- · Geno_Ctrl in [Thinking right] then Pheno_DM = DM60- Action (100,00 % of 1 examples)

· Geno_DM in [DM42- Stimulation (Motivation / Intention)]

- · Geno_Ctrl in [With RSK]
  - · Pheno_Temp in [Present]
    - · Geno_Focus in [04 BSPP Staff (any) - Rescue Force] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
    - · Geno_Focus in [06 People present Outside - Stressors] then Pheno_DM = DM44- Orientation (Action Design) (100,00 % of 1 examples)
    - · Geno_Focus in [03 Daughter's condition - Victims] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
    - · Geno_Focus in [01 Priority to find missing dog - Duty & Intervention] then Pheno_DM = DM10- Acquisition (66,67 % of 3 examples)

· Geno_Focus in [07 Shootings & Attack - Traumatic experience] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
· Geno_Focus in [04 Veterinary - Rescue Force] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
· Geno_Focus in [04 Forensics' envelops - Rescue Force] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
· Geno_Focus in [01 Intervention's proper end - Duty & Intervention] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
· Geno_Focus in [03 Victims' destination - Victims]
· Pheno_Focus in [04 Medics - Rescue Force] then Pheno_DM = DM10- Acquisition (100,00 % of 1 examples)
· Pheno_Focus in [01 Intervention's proper end - Duty & Intervention] then Pheno_DM = DM50- Selection (100,00 % of 1 examples)
· Geno_Focus in [02 Search for casualties in neighbouring villas - Safety] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)
· Pheno_Temp in [Past] then Pheno_DM = DM01- Attention & STM (100,00 % of 1 examples)
· Pheno_Temp in [Future] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
· Geno_Ctrl in [Reliance]
· Pheno_Focus in [01 Priority to find missing dog - Duty & Intervention] then Pheno_DM = DM42- Stimulation (Motivation / Intention) (100,00 % of 1 examples)
· Pheno_Focus in [02 Danger & Risks - Safety] then Pheno_DM = DM21- Analysis (100,00 % of 1 examples)
· Geno_DM in [DM02- Metacognition]
· Pheno_Agency in [Safety] then Pheno_DM = DM31- Appraisal (100,00 % of 1 examples)
· Pheno_Agency in [Manœuvre]
· Pheno_Mean_EMOTION in [s2_MildNegative] then Pheno_DM = DM03- LTM (100,00 % of 1 examples)
· Pheno_Mean_EMOTION in [s1_SignificantNegative] then Pheno_DM = DM10- Acquisition (100,00 % of 2 examples)

[309] MOS : Margin of Safety (distance to danger) ; MOM : Margin of Manoeuvre (space, time, right, social support, …)

[310] *"Self-regulation is the process in which people seek to bring themselves (their behaviors and self-conceptions) into alignment with relevant goals and standards. […] Higgins (1997, 1998) proposed that people are guided by two distinct self-regulatory systems, one with a promotion focus and the other with a prevention focus. Three factors differentiate a promotion focus from a prevention focus: the needs that people seek to satisfy, the standards with which people try to bring themselves into alignment, and the outcomes which are salient to them. […] safety/protection/security needs are at work when people are prevention focused. […] Other standards refer to people's duties, obligations, and responsibilities (e.g., the regulatory standards imposed upon organizations by a governmental agency); these are known as ought selves. […] when they are prevention focused they are trying to bring themselves into alignment with their ought selves. […] Human behavior is motivated by people's desires to (a) attain positive outcomes which make them better off and (b) avoid negative outcomes which make them worse off. […] The avoidance of negative outcomes is emphasized by people who are prevention focused. The more that prevention focused persons bring themselves into alignment with their ought selves, the more they experience the pleasure of a non-loss. If they fail to do so, they experience the pain of a loss. […] When prevention-focused people's safety/protection/security needs motivate them to attempt to bring their actual selves into alignment with their ought selves, negative outcomes to be avoided are emphasized*." (Brockner et al., 2002, pp. 7-8)

[311] "*Self-regulation is the process in which people seek to bring themselves (their behaviors and self-conceptions) into alignment with relevant goals and standards*." (Brockner et al., 2002, p. 7).

[312] *In total, PM #11 and 12 last a few seconds only : as a measure of their shortness, add the fastness of dogs jumping and running to the time needed for policemen to fire 15 bullets with an automatic gun*. Five seconds ?…

[313] Weber, M. (1920 / 1965). *The Protestant Ethic and the Spirit of Capitalism*, translated by T. Parsons, with a foreward by R. H. Tawney. London: Unwin University Books.

[314] PMs' and CogOps' timescales are different. We must remember here that a CogOp is supposed to last between 250 ms and several seconds, and that a Present Moment can last between some seconds and several minutes, CI Experience Phases lasting from some seconds to some tens of minutes as seen earlier. In the CogOp data set, the value of each PM's attributes is assigned to each CogOp forming this PM. Hence a flat line for the SA attribute for every PM.

[315] PM # 36 is not analysed ; it corresponds to the moment Lieutenant A suddenly realises bullets might have wounded neighbours.

[316] This clause means : Ctrl = [With RSK] occurs in 99,66 % of 294 CogOps for which Agency = [Safety]

[317] In fact, the subject's powerlessness lies with the total surprise that adverse events represent. He cannot prevent nor stop them. But in terms of his power of agency he is not powerless as Lieutenant A's data show.

[318] A specific action performed by a subject, not all his actions nor a series of actions

[319] In space and time

[320] In a context, both social-cultural and physical

[321] Lived within our body so that memories of physical moves and sensations are part of the memory of the action : "*subjective experiences are so deeply embodied in our actions and movements and in the physiological shifts*" (Stern, 2004, p. 39).

[322] Effectively performed in the real world, not just seen nor imagined

[323] In Lieutenant A's case we cannot characterise his "state of shock" at the end of PM #12. This is only an hypothesis that at the end of the few seconds of the trauma exposure the subject might have been destabilised, in a state of wobbleness.

[324] MacLean (1993), Weick (1993)

[325] The meeting of June 18th, 2013 with the BSPP's Bureau of Training Engineering (BIF) has concluded to the need to develop a new fold in the RETEX (Lesson learning) procedure taking place after the hot debriefing of major rescue operations.

[326] For Franklin & Patterson (2006), an autonomous agent is a "*system situated within and a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future (Franklin & Graesser, 1996)*.". Wang's (2009) definition of an autonomous software agent is "*an intelligent software system that autonomously carries out robotistic and interactive applications based on goal-driven cognitive mechanisms and that possesses high-level autonomous ability and behaviors beyond conventional imperative computing technologies*", and systems of autonomous agents can be classified in four categories :

		BEHAVIOUR	
		CONSTANT	**VARIABLE**
EVENT	**CONSTANT**	Routine	Autonomic
	VARIABLE	Algorithmic	Autonomous

[327] Such as IDA (Franklin, 2003)