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CONSCIOUSNESS AND VISION IN MAN: WHERE PHILOSOPHY HAS GONE WRONG

by

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ABSTRACT

My central claim is that philosophers of mind have failed to take adequate account of empirical evidence regarding human consciousness and vision. Experiments on split-brain patients over the past fifty years reveal consciousness in both cerebral hemispheres. I claim specifically that (a) consciousness in the right hemisphere is inherited from our animal ancestors; (b) consciousness in the left hemisphere arose during human evolution in association with language; and (c) the existence of both forms of consciousness provides the best explanation for many aspects of normal human experience.

Evidence for two cortical visual pathways in the human brain has been expanding for twenty years. The ventral pathway is specialised for object identification, and the dorsal pathway for the control of actions in respect of those objects. The evidence has been challenged by those who have failed (a) to distinguish between the visual pathways themselves and processes served by the pathways, and (b) to recognise the specific circumstances in which actions draw on one pathway. I claim that in the left hemisphere only the ventral pathway reaches consciousness.

The combination of two visual pathways with two centres of consciousness challenges traditional views about perception. I claim that (a) perception is distinct from seeing; (b) perception is limited to the left hemisphere; and (c) the parallel process in the right hemisphere is associated with the emotions. The presence of two centres of consciousness challenges traditional views on the unity of consciousness and on personhood; but it also offers an explanation for conflicting views on the emotions and the existence of self-deception.

I distinguish my claims about human consciousness from the Dual Systems (or Two Minds) Theory. Although there are superficial parallels, the latter theory denies that both systems/minds are conscious, and takes no account of the specialisation of the cerebral hemispheres revealed by experiments on split-brain patients. I conclude that philosophy must incorporate empirical evidence if it is to avoid claims of irrelevance.

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CHAPTER 1

INTRODUCTION

Understanding and explaining consciousness is one of the central, and most complex, issues in the philosophy of mind. In this thesis I review some empirical data relating (i) to consciousness in humans and (ii) to the human visual system; and, in the light of that data, I claim that philosophers have mostly ignored a crucial distinction regarding human consciousness. The failure to make this distinction has implications for other areas of interest to the philosophy of mind, such as perception and emotion.

Before I set out my detailed claims, it will be helpful to provide some background information on my approach to this issue. After discussing the relationship between philosophy and science, I outline my general approach to philosophy. I then review the concepts of "mind" and "mental states" before defining two distinct forms of creature consciousness and outlining how they can be identified. After a brief review of other concepts of consciousness and their relationship to creature consciousness, I set out my specific claims and some initial implications. I end the chapter with a summary.

1.1 Philosophy and science

In this part of the chapter, I explain how I see the relationship between philosophy and science, particularly neuroscience, and how I will approach and set out the empirical data on which I will build my case. I list the academic disciplines from which I will draw information, and my reasons for so doing.

The relationship between philosophy and science is two-way. Philosophers can, and should, ask the difficult questions that provoke scientists into particular lines of research. But it is also essential that philosophers develop theories that are consistent with empirical data provided by scientists. As Heil (2004, p 3) puts it, "the philosophy of mind and empirical work on the mind can and should push ahead together". Indeed, it has been said that "philosophical methods are most powerful when used with empirical data" (Prinz 2004, p 30).

However, Heil also admits that "philosophy is largely unconstrained by empirical findings" (Heil 2004, p 13), and in this thesis I will show that this lack of constraint has resulted in philosophers failing to take account of important empirical data relating to consciousness. In order to make my case, and to provide the information needed both to criticise existing theories and to propose alternatives, I must necessarily set out the empirical grounds on which I do so.

This means that the thesis contains a certain amount of data from neuroscience. However, since I am not writing for neuroscientists, I have sought to couch that data in terms that are comprehensible, and to avoid technical jargon wherever possible. When the use of technical neurological terms is unavoidable, I mark their first occurrence in each chapter with ***bold italic***, indicating that the term is included in the glossary at Appendix A.

The brain is a most complex organ and is amazingly adaptable. People regularly recover from damage to the brain, such as from a stroke, and eventually other areas take the place of some, if not all, of those that have been damaged. Furthermore, just as there are rare examples of individuals born with physical abnormalities, such as missing limbs or the heart located on the right hand side of the body, so there can be unusual variations in the brain (such as only one hemisphere developing, or the brain matter being pressed into abnormal configurations through conditions such as hydrocephalus).

All statements that I make about the brain, and particular areas within the brain, should be understood as referring to the normal human brain, unless otherwise specified. In the same way, when I talk about the abilities of humans, I am speaking of persons who are not suffering from any mental or physical disabilities. If I say humans are able to report their mental states, this statement is not disproved because some humans are aphasic, or because they may on some occasions be unconscious through a general anaesthetic.

Few present day philosophers will deny that mind and brain are intricately related. Writing in 1994, one leading neurologist says “I wish I could say that we know with certainty how the brain goes about the business of making mind, but I cannot – and, I am afraid, no one can” (Damasio 2006, p 258). A philosopher has made the same point in the following terms:

> How is it possible for conscious states to depend upon brain states? How can technicolor phenomenology arise from soggy grey matter? What makes the bodily organ we call the brain so radically different from other bodily organs, say the kidneys – the body parts without a trace of consciousness? How could the aggregation of millions of individually insentient neurons generate subjective awareness? We know that brains are the *de facto* causal basis of consciousness, but we have, it seems, no understanding whatever of how this can be so.
> (McGinn 1997, p 529)

Although McGinn comes to the conclusion that we may never be able to understand consciousness, I take the view that the problems involved can be overcome. Whilst I approach the subject of consciousness in this thesis from the viewpoint of the philosophy of mind, I do so on the basis that in this field, at least, philosophy and science are inextricably related. I draw on material not only from neurology and medical neuroscience, but also from psychology and the philosophy of psychology, and from cognitive neuroscience. My aim in using these diverse sources is twofold: to identify empirical data that are relevant to a philosophical theory of consciousness, and to find ideas and concepts arising from that data that might assist in the development of such a theory.

Having set out how I will approach the empirical data that will form the foundation for my thesis, I now turn to some underlying philosophical issues, beginning with my general approach to philosophy.

.*SUMMARY:* Philosophy must pay regard to empirical data. I will draw on neurological science, but avoid technical terms as far as possible. Any statements I make about the human brain should be understood as referring to the normal undamaged brain, unless specifically stated otherwise.

1.2 My philosophical approach

In this part of the chapter I set out those aspects of my approach to philosophy that have influenced my research into human consciousness and vision. In particular, I stress that I do not subscribe to any traditional "position", but rather draw on a range of ideas to find an answer to each separate question with which I am faced.

Even within the single field of philosophy of mind there are numerous distinct approaches to the issue of consciousness, and of the mind in general. Whilst labels such as "realist", or "representationalist", or "functionalist" may serve as useful ways of defining an approach to the philosophy of mind as a whole, they can lead to confusion if it is assumed that taking a particular stance on one issue requires taking the same stance on all other issues. My general approach is pragmatic: I take a particular view on each issue with which I am confronted, without thereby accepting "the whole package" that some may associate with that view. My position is that of Searle when he says that his "views do not fit any of the traditional labels" (Searle 1994, p 15), although I recognize the truth of what he adds by saying that "to many philosophers the idea that one might hold a view that does not fit [traditional] categories seems incomprehensible" (ibid).

At various times I will discuss consciousness in terms of a number of functions that play a role in processing sensory inputs. It may be that some of the functions I propose could be understood purely as illustrative. For example, the behaviour of birds foraging for food can be viewed functionally as a process of Cost Benefit Analysis in order to help us understand what is going on, without committing to the view that the birds are actually performing such a function (Bermúdez 2003, pp 114-5). In general, however, the combinations of mental states that I propose are intended to be understood as functions. I can therefore be classed as a functionalist, although I reject the more extreme functionalist view that mental states can be defined by the function that they perform, without regard to the physical material involved.

The philosophical school of thought termed 'eliminative materialism' takes the view that the concepts that lie at the centre of folk psychology (such as desire, hope, belief) will in due course be eliminated by a scientific understanding of the mind. I do not subscribe to this view, but this does not for me rule out the possibility that there may be some aspects of folk psychology that turn out to be eliminable. For example, I will question below whether it is appropriate to speak at all about "the mind", and wonder whether we have "a mind".

I am a naturalist in the sense that I view human mental activities as arising through the normal operation of laws within the brain (whether expressed in the language of biology, chemistry, or physics), and I take consciousness to be a natural feature of the brain (see Searle 1994, p 1). I assume that consciousness in humans arose through the process of evolution by natural selection. Although my focus is on human consciousness, I will therefore also consider evidence of consciousness and sensory processes in animals for the light they might throw on human consciousness.

I assume that mind evolved as brains became more complex, and that a certain level of complexity is needed before mind can exist. Not all activity in the brain is mental activity – much of it is purely physical and outside the interests of philosophy of mind. I believe that it is not necessary to understand, for example, how ion flows in neurons contribute to their operation, in order to comprehend perception, nor the exact manner in which memories are stored to comprehend learning, although future research may prove me wrong on these specific points. Different theorists will predict that different features of the brain are relevant as regards a philosophical theory of the mind. The claims that I am making in this thesis do not depend on the nature of the relationship between mind and brain, and so I take no definite position on issues such as supervenience or emergence.

It might be claimed that by focusing on human consciousness rather than on consciousness in general what I am undertaking is more cognitive science than philosophy of mind. Cognitive science is concerned with how the brain performs those activities that can be classed as ‘mental’ or ‘conscious’, whereas philosophy of mind is concerned with mental phenomena independently of their realisation. In defending myself against this challenge I make two points.

The first is to take the same line as Carruthers, who states that his theory of consciousness falls somewhere between philosophy and cognitive science. He adds that he is “inclined, in any case, to deny the existence of any sharp distinction” between the two (Carruthers 2000, p xvii). The second is to point out that our philosophical theories concerning mental phenomena must stand the scrutiny of empirical science. That is why we now reject the previously held philosophical views that located emotions in bodily organs other than the brain, or that assigned a pivotal role in mind to the pineal gland. It is my contention that most current philosophical views about human consciousness fail to accord with empirical findings; they must therefore be either amended or abandoned.

Having set out this broad brush picture of my approach to philosophy, I now turn my attention to two specific philosophical topics that are crucial to any discussion of consciousness. These are the ontology of mind, and the related issue of mental states.

SUMMARY: I do not claim for myself any of the traditional positions within the philosophy of mind, although I might be classed as a moderate functionalist. I take consciousness to be a natural feature of brain, arising as brains became more complex. I take no position on the nature of the relationship between mind and brain.

1.3 What is mind?

The term ‘mind’ has already been used quite a few times in this thesis, but different readers will have brought different assumptions about its meaning. If we assume that what we today mean by ‘mind’ is in essence what the ancient Greeks meant by ‘ψυχη’ (‘psyche’), then disagreements about the nature of mind have lasted around 2,500 years, that we know of. In this part of the chapter I outline three different concepts of mind, and state which I will adopt for the purposes of this thesis.

One view, and probably the most widely-held outside of philosophy, is that ‘mind’ refers to some discrete denumerable entity, such that humans are formed by a combination of body and mind. On this view, the mind can be separated from the body – for example, when people close to death report that they left their body and viewed it from a distance. Such a view underpins the Christian concept of resurrection and the Buddhist concept of reincarnation. This is the view adopted by Descartes who, in his sixth *Meditation*, describes the mind as a substance, distinct from body, in that it lacks extension, but linked to the body.

Some two and a half millennia ago, Plato proposed that mind might be understood in this way (Heil 2004, p 14), although he also put forward an alternative view – that mind is to body as the tuning of the strings is to a lyre. On this understanding, mind describes how the body is organised, and there is no implication of the existence of anything other than the physical. This concept of mind was also used by Aristotle (ibid, p 15).

The view of the mind as something distinct from the body reflects our everyday awareness of ourselves as being “inside” and distinct from the body. We see our body grow old, but we sense that the real “us” is still the age we were in our prime. However, despite the appeal of this concept of mind, it poses apparently insuperable problems. How can we fit such a mind into the physical universe? How can something non-physical cause the physical behaviour of our bodies? This forces us to look for a concept of mind that locates it in a physical context, and there are two ways in which this might be done. I will illustrate these with an analogy.

A *school* is an institution that exists physically. It does not need a specific location: schools in the Australian outback, for example, can be spread over vast distances as pupils link with their teacher by radio. Where there is a location, that location does not constitute the school: the school is formed through the organisation of teachers and pupils for the purpose of education. Thus a school is not in itself a physical object but rather an arrangement of physical objects designed for a specific purpose. There can be many such arrangements, and it is therefore both possible and reasonable to individuate schools. This village may have one school, another may have two, and so on.

However, we have a concept of *education* – the common feature of all schools. If an institution that claims to be a school is not organised so as to educate its pupils, then it is not a school. Furthermore, education can take place outside of school; for example, home schooling by parents, or self-education. Education – in this sense – is not denumerable.

If the term ‘mind’ is understood in the same way as the term ‘school’ – as a description of a particular form of organisation with a particular purpose – then it makes sense to discuss how we individuate minds. Does each person have one mind, or more than one? But if mind is like education, then it is inappropriate and meaningless to individuate ‘minds’ – there is simply mind.

Whether we regard “school” or “education” as the appropriate simile for mind, the same question arises. What sort of materials can be organised so as to constitute mind: can only animal brain matter constitute mind, or can aliens, robots or computers, for example, be minded? Answering this question is outside the scope of this thesis, which is concerned solely with mind in relation to animals and humans.

It may be helpful at this point to sum up the three ways of understanding what is meant by ‘mind’ in the following table:

	Mind as Cartesian substance	*Mind as organisation*	*Mind as abstraction*
Independent Existence	YES	NO	NO
Countable	YES	YES	NO
Compatible with physicalism	NO	YES	YES

Table 1.1 Ways of understanding the meaning of ‘mind’

I take the problems of explaining how mind as a separate substance can interact with the physical universe to be so overwhelming, that this concept of mind must be ruled out. This leaves the question of whether we should conceive of mind as an organisation, such that I could have one or more minds, or as an abstraction; in which case it makes no sense to talk about having “a mind”. (I realise that we do speak about having “an education”, so the analogy I have been using falls down at this point. Consider instead the concept of “finance”: I can point to a financial institution, but not to “a finance”.)

I am strongly attracted to the view that in time it will become evident that mind is an abstraction, and that references to “the mind” should be eliminated from folk psychology. However, I take the view in this thesis that ‘mind’ when applied to animals and humans should be understood as the organisation formed by certain brain states – what are referred to as “mental states” – for a common purpose. The issue that I will not address is how we are to understand the relationship between brain states and mental states: issues such as type identity versus token identity, supervenience, and emergence. I will simply assume that there exists a consistent relationship between certain brain states and mental states.

SUMMARY: I reject the concept of mind as distinct from, and separable from, the body. I view the term ‘mind’ as describing the way in which certain brain activities are organised in order to create consciousness, in the way that a school is organised to provide education.

I take the common purpose of those mental states that constitute mind to be consciousness, but before I consider the meaning of that term, I must consider further the issue of mental states.

1.4 Mental states

I take the view that certain brain states can be viewed as mental states because they form a part of the organisation that we call "mind". There are a number of different ways of categorising mental states and I will consider these in turn. Although I do not refer directly to the function of individual mental states in establishing these categories, I will describe combinations of mental states as functions at various points in the thesis.

1.4.1 Occurrent and non-occurrent states

One distinction that philosophers make is between occurrent mental states and non-occurrent mental states. In this section I explain the distinction, and outline how it will be reflected in my terminology. I begin with the process of learning and its creation of non-occurrent states.

The process of learning involves the formation of pathways between different neurons or groups of neurons, such that when one neuron or group of neurons is activated the other neurons are also activated. This process has been described as "cells that fire together, wire together" (Robertson 1999, p 13). The pathways that are formed in this way exist whether or not they are currently active; indeed, they continue to exist even when the mind is inactive, such as during anaesthesia. My belief that "Paris is the capital of France" does not have to be activated in order to be a belief, but only when it is activated can it contribute to my mental processes.

I will use the term 'state' in the sense of 'occurrent mental state', and will use the term 'disposition' for non-occurrent mental states. By using this term I am not adopting the behaviourist position, I am simply making the point that when a pathway has been formed in the brain, there will be a disposition to activate all the elements in the pathway whenever one element is activated. It may be that a certain level of activation is needed before the rest of the pathway becomes active, so that being disposed to believe 'p' (that Paris is the capital of France) may not result in a mental state of believing 'p' every time that neurons representing France or Paris are activated.

Although I have made a clear distinction between dispositions and states, dispositions share many features with propositional states. What I say about the latter in the following section should be understood as applying equally to dispositions.

SUMMARY: I reserve the term 'state' for occurrent mental states, i.e. states that are playing a part in mental activity. I use the term 'disposition' for non-occurrent states.

1,4,2 Types of state

Mental states can be grouped into types based on certain common features. The four main types of state that are commonly identified are as follows:

- *Propositional states:* these are states that represent different attitudes to propositions. There are a number of distinct attitudes, including belief, hope, desire and intention (in its everyday sense). Propositions comprise the statements of what is believed, hoped, desired or intended: I believe “that it will rain today”; I hope “that it will rain today”; I desire “that I drink a cup of tea”; or I intend “that I drink a cup of tea”.

- *Sensational states:* these are states that represent sensations that I am undergoing. Examples are the sensation of being tickled; the sensation of nausea; the sensation of pain. I may have a sensation of some background noise, before I realise that it is someone speaking, and I can then perceive what they are saying.

- *Perceptual states:* these are states that interpret the information that reaches me through the senses. Although I will challenge this way of understanding perception in a later chapter, it is common practice to describe verbs such as ‘see’ and ‘hear’ as perceptual verbs. Thus, seeing a tree, or hearing a bird, or feeling the computer keys that I am pressing, are all examples of paradigmatic perceptual states.

- *Emotional states:* we are all familiar with states such as fear, or excitement, or pleasure, where our mental state is matched to a greater or lesser extent with changes to our body: butterflies in the stomach, tenseness in our muscles, or a more rapid heart beat.

Although it is relatively easy to categorise states in general in this way, it is much more difficult to decide which category individual states fall into. If I say “I am afraid that it is going to rain today”, is this a propositional state expressing an attitude, or an emotional state, reporting a feeling? If I am aware of a feeling of nausea, is this a sensational state, or one aspect of an emotional state? The answer in both cases is that it could be either. This categorisation of states should be seen as a useful aid to understanding the mind, not an inflexible strait jacket into which all mental states must be forced.

Many of these states share one important feature: that they are about something. Such states are termed *intentional* states, and they are the subject of the next section.

SUMMARY: Although categories such as propositional, sensational, perceptual and emotional are useful ways of describing mental states, many states can be viewed as falling into more than one category.

1.4.3 Intentional states

Intentional states are states that represent something. If a see a tree, then my perceptual state represents the visual appearance of a tree. If I hear the wind rustling the leaves of the tree, then my perceptual state represents the sound that is created by the wind moving the tree's leaves. (I am not primarily concerned in this thesis with the question of whether in such a case there are two separate states – one visual and one auditory – or a single state that is both visual and auditory. I will however make brief reference to the unity of consciousness in chapter 5.)

Intentional states come in two forms: *first order* states and *higher order* states. A first order intentional state represents something at first hand: a tree, my hand, an idea. We can speak of the tree, or hand, or idea as being the object of the intentional state. A higher order intentional state has as its object a first order (or another higher order) intentional state. Thus if I look out of my window I see a tree: I have a first order representation of the tree. But if I think to myself "I seem to see a tree", I have a higher order state representing my experience whose object is the first-order state representing the tree. (I could be having the thought "I seem to see a tree" when there is in fact no tree to be seen, so the object of my mental state representing my experience cannot be a tree, but only an intentional state representing a tree.)

The distinction between first order and higher order intentional states will become important in what follows, when I distinguish two different forms of consciousness.

SUMMARY: Intentional states are states that represent something: if they represent another representation then they are higher order states, otherwise they are first order states.

1.5 Creature Consciousness

Trying to explain what we mean by 'consciousness' has been likened by Güzeldere (1997, p 1) to the problem of explaining time as reported by Augustine: "when no one asked him, he knew what it was; being asked, however, he no longer did". There are countless quotes in the philosophy literature about the mysterious, problematical, inexplicable nature of consciousness, and the problem is compounded by the very different senses in which the term is used.

My concern in this thesis is with one particular sense of the term – with what has been termed "creature consciousness". My concern is with the folk psychological understanding that certain creatures (including humans) are conscious, and that other creatures are not, and that consciousness is related to the complexity of the nervous system, more specifically to the brain. In the following sections I define two distinct forms of creature consciousness.

1.5.1 Basic consciousness

I suggest that there are two features common to all conscious creatures: they are sentient and sapient. By 'sentient' I mean that such creatures sense their environment: that is, certain internal states vary in ways that reflect changes in their surroundings. These are "sensational states" as described above. In this context, I take the environment to include the creature's own body other than the brain, so that sentience includes sensations such as pains. I take sentience to be necessary for consciousness, but not sufficient for it, unlike philosophers such as Rosenthal (1997, p 729) who claims that "to be conscious a person or other creature must be awake and sentient".

The view of creature consciousness that I am using in this thesis is that sentience must be accompanied by sapience for consciousness to exist. By sapience I mean the ability, however limited, to reason about the content of sensational states and to will behaviour. In taking this view I am also assuming that reasoning is possible in the absence of an external language, so that animals, for example, are capable of "thinking without words" (Bermúdez 2003). (By requiring both sentience and sapience, I am limiting creature consciousness to birds and mammals: others may adopt a wider definition.)

When I speak of a sentient creature, I refer to a creature that is currently capable of sensing its environment, not a creature that is currently sensing its environment. And similarly, a sapient creature is one currently capable of reasoning, not one that is currently reasoning. This means that a conscious creature is one that is currently capable of sensing its environment and of reasoning, although – at least in theory – it may not be doing so at this particular time. An analogy may help clarify this point.

> There are two identical houses, equipped with the same electrical facilities and the switches to control them. In both cases all the lights are off, and all the electrical equipment is off. I enter one house and switch on a light, but nothing happens. I enter the other house and switch on the light, and the light comes on. The first house was not connected, the second was.

I will adopt the term "basic consciousness" – or more briefly "B-consciousness" – for creature consciousness as I have described it (the combination of sentience and sapience). What I have described as sentience is not dissimilar to what Armstrong (2004) calls "minimal consciousness". And what I have termed B-consciousness is close to, if not the same as, what Armstrong terms "perceptual consciousness". However, Armstrong goes on to identify another sense of consciousness which he terms "introspective consciousness" (ibid, pp 610ff), and in the following section I will consider the relationship between this and basic consciousness.

> *SUMMARY:* Basic consciousness is a combination of sentience and sapience. In consists in the active ability to sense and to think, even when not currently sensing or thinking.

1.5.2 Compound consciousness

The ability to introspect is the ability to be aware of and to reason using both the content of our mental states and the states themselves. It is, as Edelman (2006, pp 14-15) expresses it, the consciousness of being conscious. This requires the capacity for higher order representations (ibid, p 15; Lowe 2000, p 190), which makes possible more complex reasoning than can be achieved with only first order representations. These two factors – higher order intentional states and the capacity for more complex reasoning – may form the foundation for the development of (external) language. I do not know whether I could be introspectively aware of what I am thinking if I did not have the ability to express my thoughts in words, but I do know that I could never know that other people were introspectively conscious if they could not report their thoughts to me using a common language.

Clearly "introspective consciousness" cannot exist in the absence of basic consciousness. I adopt the term "compound consciousness" (or C-consciousness) to refer to that form of creature consciousness that incorporates both the sentience and sapience that go to make up B-consciousness and the additional ability to introspect and verbally report that introspection. Whether this compound form of creature consciousness can be fragmented into its separate parts must await empirical evidence.

> *SUMMARY:* Compound creature consciousness combines sentience and sapience with the ability to introspect one's mental states, to use language to report their presence and their content, and to engage in complex reasoning.

1.5.3 Definitions

I have identified two forms of creature consciousness, and I will claim later that they exist separately and independently in humans. For now, the following definitions may be helpful.

> *DEFINITION 1: B-CONSCIOUSNESS is that form of creature consciousness that comprises the capacity to sense the environment and to respond with simple reasoning using the content of first order intentional states that may result in observable behaviour.*

> *DEFINITION 2*: *C-CONSCIOUSNESS is that form of creature consciousness that comprises the capacity to sense the environment, to respond with complex reasoning – using both first order and higher order intentional states – that may result in outward behaviour, and to introspect and verbally report those states.*

Having defined these two forms of creature consciousness, I now consider how they can be identified.

1.6 Identifying the two forms of creature consciousness

My purpose in this part of the chapter is to establish the means by which we can identify the presence of creature consciousness, and discriminate between its two forms. I begin with the brain and then consider behaviour, and the mental states that give rise to it.

1.6.1 Similar brains

There can be little doubt that consciousness arises from and in the brain. As Searle puts it: “studying the brain without studying consciousness would be like studying the stomach without studying digestion” (Searle 2002, p 36). I take it that Searle is referring to philosophical study of the brain, and is not denying that other specialists might well study the brain without reference to consciousness. He might well have added that it would also be pointless for philosophers to study consciousness without reference to the brain.

Although, as will be discussed in a moment, behaviour is the practical means of identifying the presence of consciousness, it is the similarity of brain that is equally important (Edelman 2006, pp 14-15). I am not claiming that only brains can support consciousness; it may well be that the time will come when we encounter conscious aliens who lack brains like ours, or when we succeed in creating conscious artifacts. What I am claiming is that at the present we are not aware of consciousness in any creature lacking a brain like ours, and it is the presence of such a brain that – at least in part – justifies our interpretation of animal and human behaviour as evidence of consciousness.

Searle stresses the importance of both factors in recognizing the presence of consciousness. He expresses it in the following terms:

> It isn’t just because a dog behaves in a way that is appropriate to having conscious mental states, but also because I can see that the causal basis of the behavior in the dog’s physiology is relevantly like my own. . . . It is the combination of these two facts . . .(Searle 1994, p 73)

Given that we are aware of basic similarities between the brains of mature humans, and the similarities between the brains of some animals and the brains of humans, then we judge the presence of creature consciousness by observing behaviour. In the next section I will consider what forms of behaviour provide evidence of consciousness.

SUMMARY: Our judgment that a creature is conscious depends in part on our recognition of similarities between their brain and ours.

1.6.2 Reasoned behaviour

In identifying the causes of their behaviour, we assume that dogs, and other conscious animals, are responding to sensory inputs in the way that they do because they have desires and beliefs that lead them to act in that way. This process of ascribing 'reasoning' or 'practical rationality' has been described by Davidson as follows:

> If someone acts with an intention then he must have attitudes and beliefs from which, had he been aware of them and had the time, he could have reasoned that his act was desirable . . . If we can characterize the reasoning that would serve we will, in effect, have described the logical relations between descriptions of beliefs and desires and the description of the action, when the former gives the reasons with which the latter was performed.
> (Davidson 1978, pp 85-86)

I make a distinction between what I will term "reasoned behaviour" and "rational behaviour". It is not sufficient evidence for consciousness that I, as the observer, can rationalise a creature's behaviour. Evolution by natural selection can produce instinctive behaviour that can be termed "rational" in creatures that lack consciousness as I have defined it. One example would be the way that a frog shoots out its tongue to catch any small black object that comes into sight: since it is likely that such an object will be a fly and therefore food, the frog's action can be termed rational, but does not provide evidence of reasoning.

There are, I suggest, two factors that provide evidence for reasoning, and thereby for consciousness. They are choice and learning.

SUMMARY: We judge creatures to be conscious when their behaviour gives evidence that it is the result of reasoning.

1.6.3 Choice and learning

In many situations there will be several distinct objects that are sensed within the environment, and several different beliefs and desires that are relevant to those objects. This means that there is not a single reaction to the sensory input that can be understood as reasoned, and an observer can deduce from the observed behaviour that a choice has been made. Picture the family dog faced with Mum putting food in its bowl, just as Dad comes in the door. Does the dog choose to eat the food or greet the newcomer?

It should be stressed at this point that I am reviewing folk psychological views about consciousness, rather than philosophical views, and that I am claiming that in folk psychology choice is seen as evidence for reasoning and therefore for consciousness. I am not claiming that choice is a feature of consciousness. It may be that philosophers could conceive of a creature that is conscious but is never faced with choices between competing beliefs or desires: that does not negate my claim that we consider animals to be conscious, in part because we see them as making choices.

Philosophers can also conceive of zombies – creatures who appear to be physically identical to humans in every respect but who lack consciousness. If such creatures existed, it might be claimed that they could be seen to be making choices, even though they are not conscious. A detailed discussion of the idea of zombies is outside the scope of this thesis; I will simply note that in practice we assume that other humans and some animals are conscious, in part because we see them make choices; and I take the view that we are justified in making that assumption.

It must also be acknowledged that there are philosophical problems with the concept of free will, and whether any creature has the capacity to choose. Determinists will claim that there could be an unbroken causal chain from the moment of the Big Bang until now that determines which chocolate I select from the box in front of me. This is a significant question for philosophers to debate, but it does not change folk psychological ideas about choice. When we see an animal appear to make a choice, we assume that it is reasoning and thus that it is conscious.

The initiation of behaviour in conscious creatures is, as I have shown, a result of choice; and the behaviour can be termed “willed behaviour”. I will use this term as another way of expressing the same thing as “reasoned behaviour”, where it is the act of willing, rather than the reasoning that precedes it, that is the focus of attention.

The other feature in the behaviour of creatures, closely related to choice and will, that provides evidence of consciousness is the ability to learn, or to be trained. A rat can be trained to find its way through a maze to get food: a dog can be trained to assist a shepherd in the management of sheep: people can be trained to become philosophers. But other animals, such as crocodiles, snails or coral, cannot be trained. We conclude that if they cannot be trained, then they cannot be learning, and if they are not learning they cannot be reasoning, and thus they cannot be conscious.

SUMMARY: Evidence that a creature makes choices and that it is capable of learning is evidence of reasoning.

1.6.4 Two caveats

So far in this part of the chapter, I have stated that – based on Folk Psychology – we identify consciousness when we see a creature behave in a way that is best explained by it having sensory states representing its environment and reasoning about the content of those states; and that we identify reasoning by evidence for choice and the ability to learn. We may be wrong in individual instances of behaviour (the man who seems to duck to avoid a bullet might have an involuntary tic that happily coincided with the arrival of the bullet); but expect to be right when we observe a creature’s behaviour over a period of time and in a variety of circumstances.

Whilst reasoned behaviour is useful evidence *for* consciousness, its absence is not proof of the *absence of* consciousness. When it comes to human behaviour, the most common evidence for creature consciousness is the use of language, and that may reveal consciousness at an earlier point in time when there was no behavioural evidence. Although we can recognize C-consciousness from behaviour that gives evidence of complex thought and higher order intentional states, the usual evidence is quite simply the use of language. I turn now, therefore, to the relationship between language and consciousness.

SUMMARY: Single instances of behaviour are insufficient evidence of consciousness. Absence of behaviour is not evidence of absence of consciousness.

1.6.5 Language and consciousness

Folk psychology recognises that sensory inputs and reasoning do not necessarily result in observable outward behaviour. There have, for example, been numerous examples of people totally paralysed, either through general anaesthesia or some form of trauma, who have reported after their recovery that they were conscious throughout the entire time. They could see, and hear, and feel pain, and they could think, even though they could provide no outward evidence of consciousness. A less dramatic example is the professor of philosophy who is found by her student apparently fast asleep with her eyes shut, but who then speaks up and says “I am not asleep; I am thinking”. It is subsequent behaviour, in the form of language, that provides evidence of the previous presence of consciousness.

In the absence of language we have no evidence that animals can introspect their mental states, nor that they have higher order mental states. It might be possible to conceive of a creature that possesses language but lacks the ability to introspect and report their mental states. It might also be possible to conceive of a creature that can introspect and has higher order states, but that lacks a language to report them. However, neither of these cases should obscure the fact that humans can introspect and report their mental states, so that when they do so we have evidence for C-consciousness.

However, two further caveats are necessary. Firstly, the inability of particular individuals to use language because of developmental or neurological deficits does not constitute proof of the absence of C-consciousness. The loss of language after a stroke, for example, does not, in and of itself, demonstrate the loss of C-consciousness. But secondly, the inability to report one’s mental states when there is no language deficit is evidence of the absence of C-consciousness. Thus if an individual’s behaviour is such that it meets the criteria for B-consciousness, but that individual (with full use of their linguistic abilities) is unable to report the mental states that resulted in that behaviour, then we can conclude that they were B-conscious but not C-conscious.

SUMMARY: The use of language is evidence of C-consciousness. The lack of language through developmental or neurological deficits is not evidence for the absence of C-consciousness. When there are no such deficits, the inability to report mental states is evidence of B-consciousness.

1.6.6 Two tests

In this part of the chapter I have focused on the folk psychological basis for identifying the presence of creature consciousness in humans and some animals, where we recognise underlying physiological similarities. Although the absence of behaviour is not proof of the absence of consciousness, we can apply certain tests to behaviour in order to identify the presence of creature consciousness and to discriminate between B-consciousness and C-consciousness.

EVIDENCE FOR B-CONSCIOUSNESS: Behaviour that provides evidence of simple reasoning, using the content of mental states to learn and make choices, where the creature either (i) is of a type that lacks language, or (ii) is of a type that possesses language but, with no developmental or neurological deficits preventing its use, is unable to use language to report those mental states.

EVIDENCE FOR C-CONSCIOUSNESS: Either (i) the use of language to report mental states and their contents or (ii) behaviour that demonstrates complex reasoning and higher order representations when there are developmental or neurological reasons for the absence of language.

In part 1.8, I will set out my claims about creature conscious in both its forms, but before I do so there is one other issue to be addressed. The term ‘consciousness’ is used within the philosophy literature in senses other than “creature consciousness”, and I should consider some of those senses of the term and their relationship to creature consciousness, at least briefly, before I focus on the latter. I turn now, therefore, to review the concepts of access, phenomenal and state consciousness, and their relation to creature consciousness.

1.7 Other types of consciousness

In this part of the chapter I review three other types of consciousness that are frequently discussed in the philosophical literature: phenomenal consciousness, access consciousness and state consciousness. My aim is to determine how, if at all, they relate to the two forms of creature consciousness that I have defined. I begin with phenomenal consciousness.

1.7.1 Phenomenal consciousness

Much has been written about the form of consciousness termed “phenomenal consciousness”, and this is usually described by variations on a claim originally made by Nagel. In a widely quoted paper entitled *What is it like to be a bat?* Nagel makes the following claims that appear at first sight to relate to what I have termed B-consciousness:

> Conscious experience is a widespread phenomenon. It occurs at many levels of animal life, though we cannot be sure of its presence in the simpler organisms, and it is very difficult to say in general what provides evidence of it . . . [T]he fact that an organism has conscious experience *at all* means, basically, that there is something it is like to *be* that organism. . . . [A]n organism has conscious mental states if and only if there is something it is like to *be* that organism – something it is like *for* the organism. (Nagel 1997, p 519 – italics in original)

I will return to the difference between conscious organisms and conscious mental states below, but for the moment I want to focus on the much quoted phrase “what it is like” and in particular what it is “like *for* the organism”. Unless philosophers have imbued the term “like” with some esoteric sense, we should be able to understand what Nagel means by applying common sense. We know that he is talking about experience, so we can imagine being asked by someone “what was that experience like for you?” There are three different ways in which we might respond.

- The first is to provide a comparison. If I know that you have had a particular experience, I can compare my experience to that. If I have had experience A, and I know that you have had experience B, then I can say “my experience was like experience B but . . .” and list some of the differences. Lewis (1997, pp 581) says that this approach is missing the point. Whilst we may well be able to compare different experiences that we have had, or to compare our experience with someone else’s, I must agree with Lewis that this does not seem to be Nagel’s sense.

- The second way to answer the question “what was it like?” is to describe. If I arrive home and tell me wife that there was an accident on the motorway, she might ask me what it was like. I could answer by describing the accident. “A motorcyclist was weaving in and out of the traffic. A car driver failed to notice him and began to change lanes. The motor cycle collided with the car and the rider was thrown across into the other carriageway.” It seems unlikely that this is what Nagel meant.

- The third possibility is to say that the experience cannot be described: it is personal and ineffable. The only way for you to know what the experience that I had is like is to have the experience yourself. This is certainly the view taken by some philosophers, who claim that phenomenal consciousness cannot be explained in physical terms. Some, like Nagel (1997) and Chalmers (2004), claim that explaining phenomenal consciousness is a hard problem, whereas

> others, such as McGinn (1997) claim that it is a problem that can never be solved.

I suggest that there is one factor underlying all three answers to the question "what was it like for you?" This is that you must have been aware of the experience in order to answer. There is a difference between being aware of an experience, and being aware of the content of a mental state. If I am driving "on automatic pilot" (a subject I will return to in a later chapter) and pull up at the traffic lights which are red, I was clearly aware of the content of my visual input (the red lights). But if my passenger asks me a little later – when I am driving normally again – what it was it like to see the red traffic lights back there, then I cannot answer, because it was not like anything, in any of the three senses.

I take it therefore – along with philosophers such as Carruthers (2000) – that phenomenal consciousness is a higher order feature of human experience. This would equate phenomenal consciousness with what I have termed C-consciousness. But is phenomenal consciousness a form of creature consciousness? Many, if not most, references by philosophers to phenomenal consciousness describe it as a form of state consciousness (Carruthers 2000, p 13; Block 1997, p 380). This is what Carruthers says:

> The most obvious and striking (and the most famous) form of state-consciousness is *phenomenal* consciousness. This is the property which mental states possess when it is *like something* to have them (Nagel's famous phrase, 1974). Put differently, phenomenally conscious states have distinctive subjective *feels*. . . So we might be asked to reflect on the unique quality of the experience we enjoy when we hear the timbre of a trumpet-blast, or drink-in the pink and orange hues of a sunset, or sniff the sweet heady smell of a rose. In all these cases there is something distinctive which it is *like* to undergo the experience . . . (Carruthers 2000, p 13 – italics in original)

Twice in this passage Carruthers uses the phrase "it is like" and I take it that what he means is "what it is like *for us*". He is talking about the "experience we enjoy". Clearly we are conscious when we enjoy our experiences, but Carruthers' explanation of that conscious experience is that it involves a phenomenally conscious state. That is, creature consciousness is to be explained by state consciousness. In section 1.7.3 I consider the implications of this claim, but before doing so I consider the issue of access consciousness.

SUMMARY: The phrase that is commonly used to explain what is meant by "phenomenal consciousness" is "what it is like". I claim that this means being aware of experience, which it turn means being in a higher order state. Phenomenal consciousness is usually viewed as a form of state consciousness.

1.7.2 Access consciousness

Whereas Carruthers assigns phenomenal consciousness a role in reasoning, Block distinguishes phenomenal consciousness from access consciousness, and claims that it is the latter that contributes to reasoning and the control of behaviour (Block 1997, p 382). He also claims that phenomenal consciousness and access consciousness can exist independently: that is, that you can be phenomenally conscious without being access conscious – and vice versa.

Block gives the following example of phenomenal consciousness in the absence of access consciousness.

> Suppose that you are engaged in intense conversation when suddenly at noon you realise that right outside your window, there is – and has been for some time – a pneumatic drill digging up the street. You were aware of the noise all along, one might say, but only at noon are you *consciously aware* of it, That is, you were P-conscious of the noise all along, but at noon you are both P-conscious and A-conscious of it. (Block 1997, pp 386-387 – italics in original)

What changes in this scenario is surely *attention*, not the form of consciousness. If I can realise that I was hearing the sound of the drill before noon, then I must have stored a memory of that experience, and if I was able to store a memory then it seems that I had access to the sound: I was simply not paying attention to it. This example fails, as I see it, to prove that phenomenal consciousness can exist in the absence of access consciousness.

However, there is a sense in which Block's distinction may have some justification. In the previous section I suggested that phenomenal consciousness might be equated with C-consciousness. What distinguishes C-consciousness from B-consciousness is the ability associated with the former to introspect and to report one's mental states. Clearly, to be B-conscious involves, among other things, the use of the content of perceptual states in reasoning. If I am B-consciously reasoning using the content of a perceptual state, then it might be said that I have access to the content of that state – even though I cannot introspect it or report it. If at a particular time I am B-conscious but not C-conscious, then I might be said to be access conscious but not phenomenally conscious.

However, when Block speaks of access and phenomenal consciousness, and when Carruthers speaks of the latter, they are both speaking about conscious mental states, not about forms of creature consciousness. In the following section therefore I turn my attention to what is meant by talk of "state consciousness".

SUMMARY: Block differentiates access and phenomenal consciousness, with only the former resulting in reasoning. I suggest that B-consciousness may be viewed as access consciousness in the absence of phenomenal consciousness

1.7.3 State consciousness

Talk of “conscious states” raises three questions: (1) what does the word ‘conscious’ mean in this context? (2) what makes “conscious” states “conscious”? and (3) how do “conscious” states bring about creature consciousness? Because these three issues are interrelated, they cannot be answered independently, and the answers must emerge from a general discussion.

Mental states are clearly not conscious in the same sense that I am conscious. Mental states are not sentient or sapient, although they undoubtedly play a role in my sentience and sapience. So why use the term ‘conscious’ to describe such states? One philosopher has made this point in the following terms:

> Given the reality of the distinction between states we are aware of being in and states we are not aware of being in, the only remaining question is that of why the word “conscious” is thus dragged in as an adjective to mark it. . . I cannot myself hear a natural sense of the phrase “conscious state” other than as meaning “state one is conscious of being in”.
> (Lycan 1997, p 759)

But this is not the meaning of “conscious” when used by Carruthers of “phenomenally conscious states”, since it implies that state consciousness arises from creature consciousness, and not the other way round. It is not the distinction between states that Lycan challenges, but only the use of the term “conscious” to mark that distinction. It is clear that philosophers writing about “state consciousness” are intending to distinguish those states of which we can become conscious from those that by their nature will remain below the level of consciousness. They use terms such as “poised” and “available” to describe the role of such states.

Carruthers speaks of “a certain sort of intentional content” being “held in a special-purpose short-term memory store in such a way as to be available to higher-order thoughts” (Carruthers 2000, p xiii). Block speaks about states that are “poised for free use in reasoning and . . . control of action and speech” (Block 1997, p 382), and Tye speaks of states whose content is “Poised, Abstract, Nonconceptual [and] Intentional” (Tye 2004, p 658). All three passages are concerned with the availability of states, not their actual use.

The claim common to all three philosophers is that the states to which they give the name “conscious” are necessary for, but not sufficient for, creature consciousness. What is not made clear is how these “conscious” states are related to creature consciousness. The problem of this approach is highlighted by Searle.

In his (2007) Searle cites examples of experiments that seek to identify the point at which a visual input becomes conscious, in order to explain how we become conscious. Two of his examples are binocular vision and gestalt switching. The first of these involves showing one eye a row of vertical lines and one eye a row of horizontal lines. The mind does not combine these to form a grid, but constantly switches between seeing vertical lines and seeing horizontal lines. The aim of this research is to find what it is that causes the mind to be conscious of one rather than the other.

Gestalt switching involves objects such as a Necker cube (see figure 1.1 below). The surface ABCD can be viewed either as the side of the cube facing the viewer, or as the base of the cube, and experimenters seek to explain how we switch between these views.

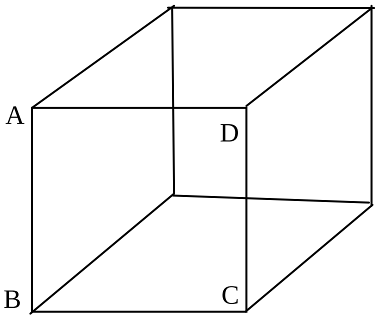


Figure 1.1: A Necker Cube

Searle says of such experiments that "I am very enthusiastic about all these lines of research but I fear that they may be making a fundamental mistake: In all of these cases, the subject is already conscious" (ibid).

SUMMARY: I concede a distinction between states of which, or in which, I can be conscious and those of which, or in which, I cannot be conscious. I reject, however, both the use of the term "conscious" to describe the former and the idea that such states can explain creature consciousness.

1.7.4 Conclusions

I have claimed that in order to make sense of "what it is like" to have a particular experience, I must be aware not only of the content of the relevant sensory input but also of the experience of perceiving that input. This is only possible with higher order representation. If the term "phenomenal consciousness" is used in the sense of creature consciousness, then I see no distinction between phenomenal consciousness and what I have termed C-consciousness: they are different terms for the same thing.

However, if "phenomenal consciousness" is used to describe a form of state consciousness, then I have questioned the use of the term "consciousness". Conscious states are described as being "available" or "poised" for reasoning and control of behaviour, but insofar as they are not used for reasoning or control of behaviour they are not states of which, or in which, I am conscious. Whilst there may be considerable value in understanding the difference between states that can reach consciousness and those that cannot, it is misleading to use the term 'conscious' of the former. Such states cannot, in and of themselves, explain how a creature is conscious.

I have also challenged Block’s claim that some conscious states can be phenomenally conscious without being access conscious. If one takes a higher order view of phenomenal creature consciousness, and accepts that access consciousness can be viewed as a form of creature consciousness, then it could be said that B-conscious creatures are access conscious but not phenomenally conscious. Accepting such a view would deny phenomenal consciousness to animals, and limit it to humans.

SUMMARY: If the term ‘phenomenal’ is applied to creature consciousness, then C-consciousness and phenomenal consciousness are the same. I question the use of ‘consciousness’ to describe mental states. In terms of creature consciousness, humans can be access conscious without being phenomenally conscious, but not vice versa.

It is not my intention in this thesis to explore this viewpoint, but to focus my attention solely on creature consciousness, in its two distinct forms. Whether mental states can be said to be “conscious”, and what form that “consciousness” might take, has no direct relevance to the claims that I make. Those claims can now be spelled out in detail, and some of their implications outlined.

1.8 My claims

In this part of the chapter I set out the specific claims that I am making in this thesis, and some of their implications. The justification for these claims will appear in the course of the following chapters and will take two forms: empirical evidence from neurology, psychology and cognitive science, and inference to the best explanation. The impact of the evidence is cumulative, so what may appear very weak at first will become stronger as further supporting evidence comes into play.

1.8.1 Claims about consciousness

In previous sections I have made clear the approach that I am taking to the issue of consciousness, and have defined two forms of creature consciousness. I am now in a position to set out three specific claims about human creature consciousness. It is my contention that existing philosophical views about human consciousness fail to take these facts into account.

CLAIM 1: Humans have two separate centres of creature consciousness, one in each cerebral hemisphere.

CLAIM 2: The form of creature consciousness located in the right hemisphere, which I term B-consciousness, is the capacity to sense the environment and to respond with simple reasoning using the content of first order intentional states.

CLAIM 3: The form of creature consciousness located in the left hemisphere, which I term C-consciousness, is the capacity to sense the environment, to respond with complex reasoning using both first order and higher order intentional states, and to introspect and verbally report those states.

I will justify these claims in chapter 2 with evidence from split brain patients and human evolution, and inference to the best explanation for various forms of human behaviour. Further evidence will arise in chapter 3, where I review recent work relating to the processing of visual input. In section 1.8.3 I make claims about vision in humans that arise from the duality of human consciousness, but before that I must consider some implications of my first three claims.

1.8.2 Some relevant definitions

One of the results of failing to make a distinction between B-consciousness and C-consciousness has been to over-emphasise the role of introspection and reporting. Behaviour that in animals would be taken as clear evidence of consciousness is dismissed in the case of humans as "unconscious" or "subconscious", solely on the basis that it cannot be reported verbally. Throughout chapters 2 and 3 I will draw attention to behaviour that, whilst unreported and unreportable, is nevertheless conscious. To avoid confusion I define the terms "non-conscious", "subconscious" and "unconscious" as follows:

DEFINITION 3: NON-CONSCIOUS describes behaviour that arises neither B-consciously nor C-consciously.

Examples of non-conscious behaviour include blinking, instinctive reactions, and actions such as tics and trembles caused by neurological damage.

When we see ourselves or another person acting in a way that (a) we cannot classify as non-conscious but (b) the sensory inputs and reasoning resulting in that behaviour cannot be introspected, then we refer to such behaviour as subconscious. In chapter 2 I will defend the view that much, if not all, of such behaviour is in fact B-conscious behaviour.

However, there are also circumstances in which we become aware of the results of reasoning without being aware of the steps involved. For example, I am doing a cryptic crossword and become stuck on a clue. Unable to solve it, I move on to other clues and then suddenly the answer to the previous cue "comes into my head". The definition of C-consciousness involved three factors that distinguish it from B-consciousness: higher order representations, complex reasoning, and introspect-ability/reportability. Since the process of solving clues in this way involves both higher order representations and complex reasoning, it cannot be considered a B-conscious process. For the purposes of this thesis, I will use the term 'subconscious' to describe thoughts and behaviour that fit into this pattern.

DEFINITION 4: SUBCONSCIOUS describes reasoning, whether or not resulting in behaviour, that gives evidence of higher order representations and complex reasoning, but which cannot be introspected or verbally reported.

In chapter 2 I will provide examples of human behaviour that is B-conscious but not C-conscious, but does not justify being classed as subconscious. I will also explore in that chapter the difference between different senses of the term ‘unconscious’.

DEFINITION 5: UNCONSCIOUS describes creatures who are either not C-conscious (but still B-conscious), or not B-conscious (and therefore also not C-conscious).

When necessary to distinguish between these two senses of ‘unconscious’ I will use Un-C-conscious or Un-B-conscious as appropriate. Examples of unconsciousness will be discussed in chapter 2: for the moment it should be noted that I take it that it is necessary to be B-conscious in order to be C-conscious, but that one can be B-conscious without being C-conscious.

SUMMARY: I have defined how I will use the terms non-conscious, subconscious and unconscious.

1.8.3 Claims about vision

The fact that human reasoning and human behaviour can arise from two separate centres of consciousness raises issues affecting several topics within the philosophy of mind. It is not possible within the confines of one thesis to explore all the relevant issues, so I will focus on the implication for how we are to understand visual processing. In chapter 3 I review the evidence accumulated over the past twenty years for two separate visual pathways, and the relationship of each pathway to the separate forms of creature consciousness.

The facts of two centres of consciousness and of two separate visual pathways combine to question traditional views about human visual processes. I make three further claims, the justification for which will be made in chapter 4.

CLAIM 4: Humans see both B-consciously and C-consciously.

CLAIM 5: Seeing and perceiving are distinct stages in the processing of visual inputs (bottom-up and top-down respectively), and perceiving is limited to the left hemisphere.

CLAIM 6: Top-down visual processing in the right hemisphere is linked to emotion.

1.8.4 Some wider implications

Within the limitations of this thesis it is only possible to consider in any depth this one area in which the fact of two centres of consciousness has an impact on philosophical theories. In the final chapter of the thesis I suggest other areas that are affected. In some cases the impact will be negative: current theories are shown to be inadequate and require either abandonment or substantial revision. In other cases the claims made in this thesis offer a possible solution to problems where there continue to be controversy and uncertainty.

That chapter will also analyse the relationship between my claims about creature consciousness and the Dual System (or Two Minds) Theory (Evans & Frankish 2009). This theory, or rather collection of theories, about the mind – that have duality as their common theme – holds that all the operations of the human mind can be divided between two distinct systems. There are indeed some significant parallels with the claims that I am making, but there are also very significant differences, not the least of which is that Dual System Theory views one system as unconscious.

1.9 Summary

In this opening chapter I have provided the background to the issues to be investigated, including the relationship between philosophy and other disciplines, and my personal approach to philosophy. I have outlined how I understand the terms ‘mind’ and ‘mental state’. I have defined two forms of creature consciousness, which I have termed basic or B-consciousness and compound or C-consciousness. I have reviewed three other ways in which the term ‘consciousness’ is used within the philosophy of mind (access consciousness, phenomenal consciousness, and state consciousness), and have concluded that although all three raise many questions, I can make and defend my claims without needing to resolve them.

I have set out three claims about human consciousness, which will be defended in chapter 2, and have referred briefly to the evidence for two distinct visual pathways in the human brain, which will be examined in chapter 3. I have set out three claims about human vision, that arise from the duality of human consciousness and dual visual pathways, and which will be defended in chapter 4. I have ended this chapter by outlining the issues that will be covered in the final chapter of the thesis.

CHAPTER 2

THE DUALITY OF CREATURE CONSCIOUSNESS IN HUMANS

In the opening chapter I defined two forms of creature consciousness that I termed B-consciousness and C-consciousness. I then described two tests by which their presence could be identified, and made three claims. These are:

1. Humans have two separate centres of creature consciousness, one in each cerebral hemisphere.

2. The form of creature consciousness located in the right hemisphere is B-consciousness.

3. The form of creature consciousness located in the left hemisphere is C-consciousness.

As will become clear in the course of this chapter, by “separate centres of creature consciousness” I mean separate systems for processing sensory inputs; forming and storing beliefs, desires, and memories; reasoning; and initiating behaviour. Some have chosen to use the term “mind” for what I have called “B-consciousness” and “C-consciousness” (see, for example, the quotation in 2.2.4 below). I will return to this issue in chapter 5. In this chapter I set out the initial evidence for my claims, drawing on three sources. Further evidence will appear in chapter 3, where I examine the implications of two distinct ***cortical*** visual pathways in the human brain.

The first source discussed in this chapter is the experimental evidence from split-brain patients. These are patients whose ***corpus callosum*** – the link between the two cerebral hemispheres – was severed in order to overcome severe epilepsy. The second source is evidence about the evolution of the brain and of consciousness. The third source is human behaviour, and instances where the co-existence of both forms of consciousness, or the absence of one form of consciousness, provides the best explanation for that behaviour.

NOTE:
In this and the following chapter I make frequent use of the term ‘perception’. This should be understood in a general sense as referring to the conscious recognition of what we see. In chapter 4 I will claim that the term should have a more limited use.

2.1 The evidence from split-brain patients

In this part of the chapter I review the evidence that has accumulated over the past fifty years concerning the consciousness that split-brain patients demonstrate, whether they are using their right or their left hemisphere. I begin with a brief historical survey, before reviewing some of the empirical findings and their implications. I conclude this part by showing that the differences between the two hemispheres can be explained by the presence of B-consciousness in the right hemisphere, and C-consciousness in the left hemisphere.

2.1.1 The historical background

In the 1960s several patients suffering from a severe form of epilepsy underwent ***commissurotomy***, a medical procedure that severs the *corpus callosum*. This separated the two cerebral hemispheres, so that information could no longer pass between them, and the surprising fact is that for the patients concerned life went on – after recuperation and minus the epilepsy – without significant change. They could navigate the world around them, read and write, and generally behave like those of us with the link between the hemispheres intact.

However, when these patients were studied more closely, a very different picture emerged. These studies were undertaken initially by Roger Sperry and his colleagues, and resulted in him being awarded the Nobel Prize in Physiology or Medicine in 1981. In his acceptance speech, Sperry reminded his audience of the classical view of a “leading, more highly evolved and intellectual left hemisphere and a relatively retarded right hemisphere . . . lacking generally in higher cognitive function” (Sperry 1981, p 1). However, after reviewing the evidence from split-brain patients he presented a different picture.

> Each brain half . . . appeared to have its own, largely separate, cognitive domain with its own private perceptual, learning and memory experiences, all of which were seemingly oblivious of corresponding events in the other hemisphere . . . Each hemisphere . . . appeared to be using its own percepts, mental images, associations and ideas . . . each could be shown to have its own learning processes and its own separate chain of memories, all of course, essentially inaccessible to conscious experience of the other hemisphere. (Sperry 1981, pp 2 & 3).

In his brief biography of Sperry, published on the Nobel Prize web site, Horowitz (1997, p 3) quotes Sperry as saying of the right hemisphere that it is “a conscious system in its own right, perceiving, thinking, remembering, reasoning, willing and emoting, all at a characteristically human level”. Horowitz ends his biography by claiming that “the discovery of the duality of consciousness . . . opened up whole new fields of brain research, and these are now being worked by a new generation of biologists, and, of course, philosophers” (ibid).

Despite Horowitz’s claim, if you were to look through introductions to the philosophy of mind, or philosophy of psychology, published since 1981, or survey the philosophical literature of the past forty years, you would find remarkably little reference to Sperry’s findings. I have found two papers on the philosophical implications of discoveries about split-brain patients dating from the seventies: by Nagel (1971) and

Puccetti (1973). Either most philosophers have remained in ignorance of the evidence from split-brain patients, or they have concluded that it is irrelevant.

SUMMARY: Experimental data from split-brain patients reveal consciousness and cognition in both hemispheres. These data have been mostly ignored in the philosophical literature.

Before I review the detailed experimental evidence from split-brain patients, I will consider one possible explanation for such a conclusion.

2.1.2 The relevance of split-brain evidence

It might be claimed that creature consciousness in the intact brain is a single function with its neural correlates shared between the hemispheres. The fact that the neural correlates of some functions are limited to one hemisphere – Wernicke's area correlating with understanding language, for example – does not mean that all such functions must be limited to one hemisphere. Perhaps, it might be said, a unitary consciousness shared between the hemispheres is severed when the *corpus callosum* is severed, but the separate parts retain sufficient functionality to continue to operate, albeit at a reduced level.

If this were the case, then evidence from split-brain patients would be irrelevant to our understanding of consciousness in the majority of humans with intact brains. However, the evidence from evolution and from everyday human behaviour, which will reviewed in the rest of this chapter, both point to the fact that consciousness was separate in split-brain patients before their hemispheres were separated.

The evidence from split-brain patients should therefore be assessed with an open mind, assuming that the case for dual consciousness in the undivided mind will be made. What commissurotomy provides is the opportunity to examine each centre of consciousness independently. I begin my review of the evidence with some features of the mind that are divided between the hemispheres in the intact brain.

SUMMARY: Whilst it might be claimed that a single unified consciousness shared between the hemispheres is divided by commissurotomy, the evidence from evolution and from everyday human behaviour denies this possibility.

2.1.3 Visual input and motor control

In this section I consider two areas of mental processing – visual input and the control of bodily movements – that are divided between the two hemispheres in the intact brain. When the hemispheres are divided, therefore, we have the opportunity to assess their operation independently.

The right cerebral hemisphere receives visual data from the left visual field (the left hand side of each eye), and the left hemisphere receives visual input from the right visual field (Gazzaniga et al 2002, p 152). The right hemisphere maps somatosensory inputs from, and motor commands to, the left side of the body; the left hemisphere does the same for the right side of the body (ibid, pp 64-65). In the intact brain the output from the visual processing in each hemisphere is transmitted to the other hemisphere via the *corpus callosum*, and commands controlling the movement of the body can be passed between hemispheres in the same way (see figure 2.3 on page 52).

One result of this arrangement is that objects can be presented in the visual field in such a way that the initial processing of the visual information takes place in one specific hemisphere. If an object is displayed to a split-brain patient in such a way that it is located in the left visual field, the visual input is received by the right hemisphere. In tests, the patient is unable to name the object (even though they have understood the verbal instructions they received – see 2.1.4 below), but if a list of words is displayed, including the name of the object, then the patient is able with their left hand to indicate that name.

By contrast, if an object is displayed in the right visual field and is thus perceived by the left hemisphere, a split-brain patient has no difficulty in naming the object in speech. I will return to the issue of language and the two hemispheres in the next section, but at this point I focus on the evidence for consciousness. In both of these cases there is evidence of perception (they see the object) and reasoned behaviour (they are able to communicate their identification of the object), and the combination of perception and reasoning is proof of creature consciousness. In later sections I will discuss the relationship between language and consciousness, and will review further experimental data from split-brain patients. For the moment, however, I return to the subject of motor control.

Motor control is organised hierarchically (Gazzaniga et al 2002, pp 451ff), and in general terms we can break it down into three steps: strategic planning, tactical planning and implementation. The first stage can take place in either hemisphere, but implementation (and probable tactical planning) utilises the contralateral hemisphere. (That is why the patient described above used their left hand to point out the name of the object visible to their right hemisphere.) Evidence will arise in chapter 3 for a specialised Action Command Module (ACM) in the left hemisphere, but as the above experiment demonstrates, actions can be planned in the right hemisphere as well.

The control of actions in either hemisphere is not completely independent, however. In one experiment, individuals were asked to draw two simple images displayed separately in each visual field, using both hands simultaneously. Brain-intact participants could only complete the task if the images were either identical or mirror reversed, but split-brain patients were not limited in this way (Gazzaniga 2000, p 1299).

There could be a number of explanations for the limitation revealed in brain-intact participants, and further work is needed to choose between them. One possible factor is a reduction in the resources available in the left hemisphere for visual processing, perhaps created by the development of language (see 2.1.5 below).

SUMMARY: In the undivided brain, the two hemispheres process visual input from the contralateral side of the visual field, and control movement in the contralateral side of the body. This fact allows experimenters to isolate how each hemisphere in split-brain patients responds to visual input. In the undivided brain the control of bodily action exercised by each hemisphere is limited when two different courses of action are involved.

2.1.4 Language and the two hemispheres

As has been shown in the previous section, split-brain patients can understand commands using their right hemisphere, and can use their left hand to select the name of the object being presented to that hemisphere. This could be taken to show that the right hemisphere has linguistic abilities, and that consequently split-brain patients using their right hemisphere are C-conscious, but this would – I suggest – be to misinterpret the evidence.

Language comprises very much more than the ability to attach labels to objects, or to properties of objects, such as colour. Many animals use sound to communicate but few, if any, possess language. Recognising that a pattern of marks on a piece of paper correlates with a particular object does not constitute reading: especially when that correlation was learned when both hemispheres were still linked. Language involves the ability to combine words, or to recognise combinations of words, in order to convey meaning.

There is no evidence that split-brain patients using their right hemisphere can do anything like this: their abilities are not much more advanced than a dog that learns to obey spoken commands. In one test of split-brain patients, the right hemisphere was shown two words in succession, and the patient was asked to point to a picture illustrating what they had read. Shown the words “pan” and “water”, for example, the patient was unable to select a picture of a pan filled with water (Gazzaniga et al 2002, p 414). In a similar test, the patient was asked to select one word from a list of six that linked two words previously displayed. Shown the two words “pin” and “finger”, the patient was unable to select the term “bleed” from the list of options (ibid, p 680).

I conclude, therefore, that the right hemisphere in split-brain patients lacks language. Sperry (1981, p 2) reports this hemisphere to be “mute and agraphic” although “able to comprehend, at a moderately high level, words spoken aloud by the examiner”. This is a clear contrast to the left hemisphere, which shows no problems in both using and understanding language. This difference between the hemispheres has a number of implications, and one of these will be the topic of the following section.

SUMMARY: Although using their right hemisphere split-brain patients can understand simple verbal instructions, and match objects with the written form of the name of the object, this falls short of genuine linguistic ability.

2.1.5 Dissociations in visual processing in the two hemispheres

It appears that one of the results of developing language in the left hemisphere was the loss of some of the resources originally devoted in that hemisphere to visual processing. The result is that there are some visual discriminations that can be made by the right hemisphere but not by the left (Gazzaniga 2000, p 1304-5). When only part of a shape is visible, the brain can complete the whole shape in a process called "amodal completion". Given the picture shown in figure 2.1 below, both the left and right hemispheres in split-brain patients can identify whether the centre white block is thick or thin.

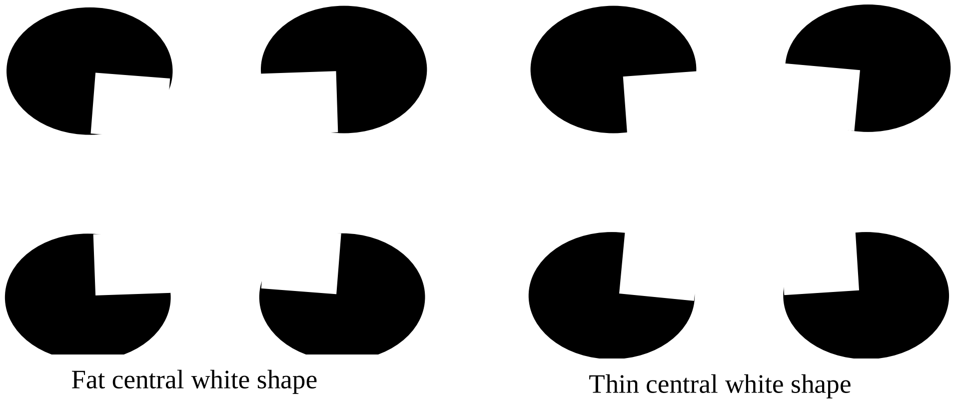


Figure 2.1: Recognising underlying shape: case 1

However, if the picture is modified by completing the outline of the white triangles (see figure 2.2 below), then the left hemisphere in split-brain patients cannot differentiate between the fat and thin shapes, whilst the right hemisphere can do so. Since experiments with mice suggest that they see shapes by amodal completion (ibid, p 1305), this ability appears to have evolved before the specialisation of the hemispheres in *homo sapiens*, which resulted in its loss from the left hemisphere.

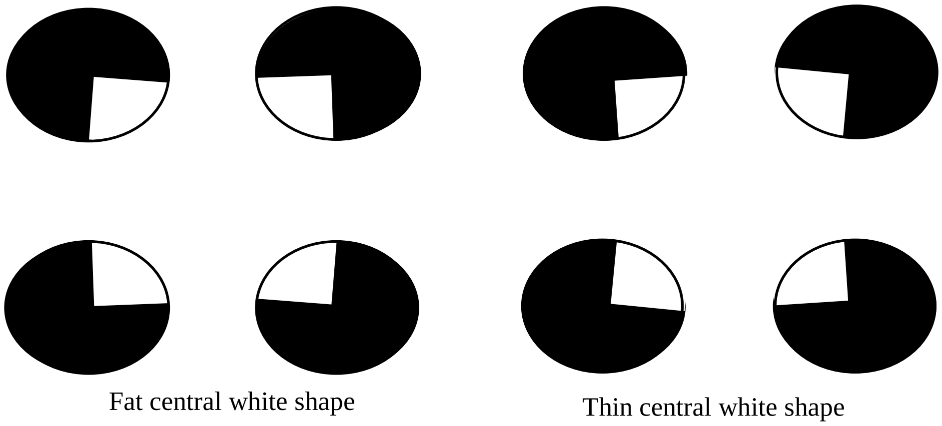


Figure 2.2: Recognising underlying shape: case 2

Another test with split-brain patients (Gazzaniga 2000, p 136) also shows a clear difference between visual processing in the two hemispheres. In this test two square frames are presented in a single visual field with a small icon in one of the corners in each frame. In one version of the test, the participants had to decide whether the two icons were in the same location (the “spatial” test); in the other version, they had to determine whether both icons were the same (the “identity” test). The left hemisphere appeared slightly better than the right at the identity test, but the right hemisphere performed significantly better at the spatial test. (I will return to this issue in chapter 3.) The experimenters interpret this result as being consistent with the idea that the evolution of language in the left hemisphere has resulted in the loss of some visuospatial abilities it once possessed (ibid).

SUMMARY: The right hemisphere is significantly better than the left in several types of visual discrimination, perhaps because the development of language took over left hemisphere resources previously used for vision.

2.1.6 Dissociations in reasoning in the two hemispheres

There is also a difference in how each hemisphere performs in tests involving recognising whether a stimulus had been previously presented. The left hemisphere is prone to more errors, falsely identifying similar items as being the same (ibid, p 1313). This appears to be related to a significant difference in how stimuli are processed. It appears that the left hemisphere categorises stimuli and theorises about them. Thus if a spoon is presented to the left hemisphere, this may be stored not simply as “spoon” but also as “cutlery”. If a fork appears later this is also categorised as “cutlery” (as well as “fork”) and may then be wrongly identified as a previously seen item. One of the results of this difference in how the two hemispheres process visual information is that information about inputs in the left visual field reaches B-consciousness more quickly than information about inputs in the right visual field reaches C-consciousness.

The theorising and problem-solving abilities of the left hemisphere may be associated with a specialised module named the “Interpreter Module” (ibid, p 1316), which was originally identified as a result of tests on split-brain patients. In one test, a picture of a chicken claw was displayed in the right visual field (processed by the left hemisphere) and a snow scene was displayed in the left visual field (processed by the right hemisphere). An array of pictures was then placed in front of the patient (ie, accessible to both hemispheres). Asked to choose two pictures associated with those previously displayed, the patient chose a chicken with his right hand (controlled by the left hemisphere) and a shovel with his left hand (controlled by the right hemisphere).

Although the link between snow and shovel may have been obvious to the patient’s right hemisphere, the left hemisphere did not have access to the original snow scene, nor to the logic that had led to the selection of the shovel. When asked why he chose the chicken and the shovel, the patient’s immediate response was that “the chicken claw goes with the chicken, and you need a shovel to clean out the chicken shed” (ibid, p 1316). It should be noted that this was not presented as a tentative explanation of what had happened, but as an immediate and accurate statement. In part 2.3, I will discuss evidence for similar behaviour where the brain is still intact.

The existence of the Interpreter Module and the consequent difference in how perceptual inputs are processed in the two hemispheres has other implications. It has been shown that after commissurotomy the disconnected left hemisphere retains the problem-solving abilities of the intact brain, whereas the right hemisphere shows a very marked deterioration (ibid, p 1315). This is consistent with the left hemisphere having the complex reasoning skills associated with the development of language, and the right hemisphere having more limited reasoning abilities.

SUMMARY: The left hemisphere includes a specialised module – the Interpreter Module – that seeks to form theories about sensory inputs. This can lead to errors when asked to decide whether an object has been previously seen. When unaware of right hemisphere reasoning, it can lead to confabulation. The left hemisphere of a split-brain patient retains the intelligence of the intact brain, but the right hemisphere shows a significantly lower intelligence.

Having reviewed the evidence for a number of clear differences between the abilities associated with each of the hemispheres, I am now in a position to determine the form of consciousness located in each hemisphere. This is the topic of the following section.

2.1.7 The duality of human consciousness

The differences in the roles of the two hemispheres which have been identified in split-brain patients appear to bear out not only the claim that humans have a centre of consciousness in each hemisphere, but also the claim that the two hemispheres have distinct forms of consciousness. Whilst consciousness in the right hemisphere is superior in “some perceptual and attentional skills, and perhaps also emotions, it is poor at problem-solving and many other mental activities” (ibid): it is a basic form of consciousness that humans share with other animals, ie B-consciousness.

The form of consciousness found in the left hemisphere of humans is associated with the ability to categorise and theorise about their perceptual experiences, and to excel in problem-solving tasks. These skills are accompanied by, perhaps in some way depend on, the ability to introspect and to report verbally on the results of that introspection. These factors provide the evidence for the presence of C-consciousness.

SUMMARY: B-consciousness resides in the right hemisphere and C-consciousness in the left (see Claims 1, 2 and 3 on pages 26 & 27).

If both forms of consciousness exist in modern humans whose brains remain intact, (an issue to be discussed more fully in part 2.3), then there should be evidence of their separate evolution. That is the topic of the next part of the chapter.

2.2 The evolution of human consciousness

In this part of the chapter I draw on evidence from tool making to demonstrate the presence of reasoning, and thus of consciousness, in primates and early hominids. I then summarise the evidence for a major evolutionary change in *homo sapiens* that resulted in the specialisation of the cerebral hemispheres and the development of a new form of consciousness. I start with a very brief survey of the evolution of the brain.

2.2.1 The evolution of the brain

It took some four and a half billion years of evolution to get from the first unicellular organisms to the beginnings of a brain in multicellular organisms (Joseph 1996, pp 1ff). This primitive brain continued to develop until, with the coming of the reptiles, we find some clearly defined areas that are familiar today to students of human neurology. These include the ***brainstem***, the ***cerebellum***, and those areas that form the major part of the ***limbic system*** – the ***amygdala,*** the ***hippocampus*** and the ***thalamus***.

Thereafter the evolution of birds and mammals sees the continuing enlargement of the ***neocortex***, until it reaches its maximum size in humans. At some point during this process consciousness began. Although there are some cases of parallel development in different evolutionary lines, there is no reason to doubt that consciousness in humans evolved from more primitive forms of consciousness in our primate and early hominid ancestors.

2.2.2 Consciousness in wild chimpanzees

Chimpanzees in the wild use simple tools constructed from plants to gain access to ants and termites as a source of food (Bermúdez 2003, p 55 – citing Byrne 1995). For ants, they select a stick that is several feet long and then strip off the leaves and leafy stem. For termites they select a much shorter and more flexible wand, from either vines or twigs, and chew the end. The tools are selected and prepared at some distance, both spatially and temporally, from the location where they will be used.

It has been suggested that this behaviour is innate, and that no genuine thought is involved (ibid, p 126), since chimpanzees born in captivity are seen to poke long thin things into holes. But, points out Bermúdez, this ignores the fact that chimpanzees construct the appropriate tool for the type of food that they are seeking, and that they do so well in advance, ruling out claims of trial and error.

This chimpanzee behaviour provides evidence of perception of both the presence and the properties of the sticks that are chosen, of belief that the treatment they give the selected stick will create the appropriate tool, of a desire to obtain food, and of choice between ants and termites as the target food source. The combination of these perceptions, desires and beliefs is evidence of reasoning, and therefore of consciousness. Since chimpanzees lack language, we have no evidence to support a claim of C-consciousness, but can be confident of identifying B-consciousness.

SUMMARY: Wild chimpanzees choose whether to search for ants or termites, and construct the appropriate tool. This is clear evidence of creature consciousness, and suggests that humans inherited this form of creature consciousness from their animal ancestors.

2.2.3 Consciousness in early hominids

A similar case for reasoning (and therefore consciousness) can be made for tool-making *homo habilis*, the forerunners of *homo sapiens*. Bermúdez describes the process as follows:

> Considerable technical skill is required to make a hand-axe. Since the hand-axe is symmetrical, the flakes need to be removed from alternate sides. Each nodule is different. With different stresses and fracture lines, and the toolmaker needs to keep in mind a specific goal and adjust his blows accordingly. The force of the blows needs to be precisely calculated. The entire process is highly complicated and dependent on constant feed-back. A highly developed form of instrumental rationality is at work here, feeding into action.
> (Bermúdez 2003, p 127)

Here again we have clear evidence of perception, beliefs and desires being integrated by reasoning to produce reasoned behaviour, and thus providing evidence for consciousness. As with the chimpanzees, the evidence points to B-consciousness.

SUMMARY: Evidence of tool-making by early hominids is evidence of creature consciousness. This confirms that humans inherited creature consciousness from their ancestors.

With evidence for B-consciousness in primates and in *homo habilis*, we are justified in assuming that *homo sapiens* inherited B-consciousness. But a major change occurred during the evolution of *homo sapiens*, and this will be the subject of the following section.

2.2.4 Evolution of consciousness in homo sapiens

This evolutionary change in human consciousness has been described by Joseph (2008a) in the following terms:

> With the appearance of language, profound artistic expression, self-consciousness and right and left brain functional specialisation, a

> schism had formed in the psyche of man. Whereas before there had been a more or less unified mind, now there was a new and additional form of mental processing which also gave birth to . . . the capacity to reason and form complex thoughts. By at least 100,000 years ago . . . a fragile and minimally developed linguistic consciousness probably emerged from what had been the original mind . . . This original mind has not been discarded, however. Rather, as the left brain became increasingly associated with language and linguistic consciousness, this original mind appears to have also evolved and to have become more intimately associated with the right cerebral hemisphere. It is probably for these reasons that among modern human beings, the right hemisphere is associated with the presumably more primitive unconscious whereas the left brain maintains . . . the more recently evolved, language-dependent, conscious mind. (Joseph 2008a, p 3)

I will raise objections (see below) to some details in this description of human evolution, but I take the general picture to be accurate. Joseph is saying that the mind (and I take it that mind includes consciousness) that *homo sapiens* inherited from its ancestors, became restricted to the right hemisphere. Alongside it there developed a faculty in the left hemisphere associated with language, which Joseph terms “the conscious mind”.

Joseph’s terminology is in line with that used by proponents of the Dual System (or Two Minds) Theory, mentioned in chapter 1, which identifies two separate systems in the human brain – one conscious and one unconscious. This use of the term ‘unconscious’ appears to relate to the sense of ‘un-C-conscious’, and means simply that the “unconscious” mind cannot introspect its states and cannot report their presence or their contents verbally. If Joseph were right in claiming that the “mind” now limited to the right hemisphere is not conscious, then either animals are not conscious (despite the evidence quoted above for chimpanzee consciousness) or humans lost consciousness in the right hemisphere when they gained a new form of consciousness in the left hemisphere. The evidence from split-brain patients clearly shows that this is not the case.

I therefore reject the claim by both Joseph and Two Minds theorists that the mind associated with the right hemisphere is unconscious. I also reject Joseph’s claim that the capacity for reasoning *per se* is associated with this evolutionary change. I have already provided evidence for reasoning both by chimpanzees and early hominids. The parallel developments in the left hemisphere that took place as part of the specialisation of the two hemispheres, including language and logic, resulted in the ability in indulge in far more complex forms of reasoning than had previously been possible, but did not introduce the ability to reason.

The fact that animals and early hominids were conscious, and that this consciousness pre-dates the evolutionary change in man that resulted in the development of language, means that this original form of consciousness is what I have termed B-consciousness. Joseph’s claim that B-consciousness became restricted to the right hemisphere is borne out by the evidence from split-brain patients. The development of a new and more sophisticated form of consciousness in the left hemisphere, including the capacity for language, marks this as C-consciousness.

SUMMARY: In the course of human evolution, alongside the development of language, there developed a form of creature consciousness associated with language and located in the left hemisphere. The form of creature consciousness inherited from our animal and early hominid ancestors became restricted to the right hemisphere.

I turn now to the third source of evidence for two distinct forms of consciousness: instances of human behaviour. Some of this behaviour arises in experimental conditions, but much of it arises in everyday life.

2.3 Evidence from intact-brain human behaviour

In this part of the chapter I examine various instances of human behaviour where the fact of two distinct forms of consciousness provides the best explanation. I start with the experience referred to as "driving on automatic pilot", before reviewing some experimental data which reveals B-conscious behaviour resulting from reasoning that is unavailable to C-consciousness. After a case of "repressed memory", I end this part with issues relating to sleeping and dreaming.

2.3.1 Driving on automatic pilot

In this section I compare the experience of "driving on automatic pilot" with the actions of people in the throes of a *petit mal* seizure. I conclude that the former case is illustrative of the presence of both B-consciousness and C-consciousness, but not the latter.

SCENARIO 2.1

Imagine the situation. You are on your way home after a riveting philosophy seminar and considering an important and exciting train of thought. You suddenly become aware that you have been driving for several miles without any awareness of the road and the traffic on it. Since your passenger has not screamed in fear, and since you have not had an accident, it has to be assumed that you have successfully negotiated your way around other vehicles, responded to traffic lights, taken the correct route at several junctions, and generally behaved as if you were aware of your surroundings.

The fact that you were aware of your philosophical ruminations and can both recall and report them is clear evidence of C-consciousness. But your inability to recall or report on your actions in driving the car shows that these actions, and the reasoning behind them, were not C-conscious. Is this therefore a case of driving subconsciously?

In chapter 1, I drew a distinction between subconscious and B-conscious behaviour. For behaviour to be subconscious it needed to show evidence of thought involving higher order representations and complex reasoning, and neither of these is necessary to explain the thought processes controlling driving. There is therefore no basis on which to view it as subconscious behaviour. There are, however, grounds for regarding driving in this situation as being B-conscious. This becomes clear when driving on automatic pilot is compared with driving during an epileptic seizure.

Searle (1990, p 635 cited in Block 1997, p 399) makes a different claim. He distinguishes between "unconsciousness" and "peripheral consciousness", and claims that the driver in this situation is peripherally conscious of the road conditions but is not paying attention to them. "It is simply not true," he says, "that I am totally unconscious of these phenomena. If I were, there would be a car crash (ibid)." However, as Block (1997, p 397) points out, this is in conflict with Searle's later claim that a person who suffers a *petit mal* seizure but continues to drive home without crashing is totally unconscious (Searle, 1992, pp 108-109).

Both Block and Searle are citing Penfield (1975) who reports a number of case studies of patients suffering *petit mal* seizures who continue with activities such as playing the piano, walking home or driving their car. Van Gulik (1989, p 220) cites Penfield's work before summarising what happens in such cases by saying that "the patient suffers a loss of conscious experience in the phenomenal sense although he can continue to react selectively to environmental stimuli". Block (1997, p397) takes the opposite view, claiming that the *petit mal* sufferer remains phenomenally conscious but loses access consciousness. For Block, the fact that the driver in the throes of a seizure does not crash, and that the pedestrian "threads his way" through the crowds, is proof that they are conscious.

In chapter 4 (section 4.1.2), I will propose an explanation for how someone can continue to drive along a well-known route, and avoid other traffic in the process, whilst in the throes of an epileptic seizure (and both un-B-conscious and un-C-conscious). What the driver in these circumstances cannot respond to are red traffic lights (Penfield 1975, p 39). A red traffic light is not a physical obstruction: it is a conventional signal that requires reasoning to interpret. Since our driver on automatic pilot correctly responds to that signal, he clearly is reasoning and is therefore conscious. This must be a case of B-consciousness, since both C-consciousness and subconscious behaviour have already been ruled out.

At this point I will claim that in the case of driving on automatic pilot the best explanation is that the person concerned is thinking about something other than their driving C-consciously, and is driving B-consciously. This explanation is consistent both with the facts of the particular situation, and with the broader picture of two forms of consciousness existing side by side in the human brain.

SUMMARY: Driving on automatic pilot can be understood as driving B-consciously whilst thinking about something else C-consciously. It is to be distinguished from continuing to drive during a *petit mal* seizure, since in the former case the driver obeys traffic lights, but in the latter does not.

2.3.2 Consciousness and visual perception

The evidence from split-brain patients cited in part 2.1 above makes clear that each hemisphere can have perceptual experiences; and to have a perceptual experience that results in reasoned behaviour is to demonstrate consciousness. In this section I make the case that independent visual perception and consciousness can be identified in everyday human behaviour.

One of the findings from studies of split-brain patients is that the right hemisphere processes visual inputs more quickly than the left, so that they reach B-consciousness before they reach C-consciousness. Keep that in mind as you read the following scenario.

> *SCENARIO 2.2*
> A soldier is on patrol in a city in one of the world's trouble spots. As he makes his way down the street he suddenly halts, and he brings his gun to bear on a rooftop across the street. "What's up?" asks one of his comrades. "I must have seen something on that roof over there," the soldier responds. "I'm not sure what. It might have been the sun catching something metallic. Why else would I have raised my gun?"

In this scenario the soldier responds to something he sees, but he cannot think about or verbally report the content of his perceptual experience. He can report that he was on patrol, he can describe the street down which he was walking, and he can report that he was carrying a gun. All of these are C-conscious experiences. He can also report that he brought his gun to bear on a target, but he cannot report what he saw on the rooftop or the reasoning that led him to bring his gun into readiness: he can only speculate on these experiences. So either it was a case of subconscious reasoning or of B-conscious reasoning.

There is no justification for assuming that his actions were subconscious. The thought process that led to him raising his gun does not demand higher order representations or complex reasoning, which are the defining features of subconscious behaviour. The fact that he reacted in a reasoned manner to a visual input is consistent with B-consciousness. I take this to be another case where the coexistence of both B- and C-consciousness provides the best explanation.

> *SUMMARY:* There are circumstances in which we respond B-consciously to stimuli of which we are not C-conscious.

From a case that illustrates independent visual perception and reasoning, I turn now to a case of independent memory and an actual case of B-conscious reasoning causing behaviour that could not be explained C-consciously.

2.3.3 Consciousness and memory

Sperry (1981, p 2) reached the following conclusion from his study of split-brain patients. “Each brain half,” he says, “appeared to have its own, largely separate, cognitive domain with its own private perceptual, learning and memory experiences.” In this section I review a case of a B-conscious private memory experience.

Memory can be divided into two broad categories: declarative and non-declarative. The latter term describes memories that we cannot consciously retrieve, such a how to ride a bike. My concern in this section is with declarative memories: those that we can access consciously. Declarative memories are divided into two kinds: semantic and episodic. The former are those that are stored using language: not just words and their meanings, but any information that is stored verbally. Episodic memories are those that are stored without the use of words: memories of what it felt like to kiss your first girlfriend, or your memory of a piece of music.

Many memories are interwoven: you hear a piece of music and recognise it, and you are able to identify its name and the composer. Something triggers a memory of your first girlfriend’s name and that leads to a memory of your first kiss. Often, however, we fail to join the links. We hear a piece of music and recognise it, but we cannot remember its name, or the name of the composer. We can clearly recall our first kiss, but cannot remember our first girlfriend’s name. There are also some memories that are only stored episodically, because the experience occurred before we acquired the language skills to store it semantically. Such memories are sometimes termed “repressed memories”, but the problem may not be unwillingness to retrieve them, but rather inability.

Since language is related to C-consciousness and linguistic processes are located in the left hemisphere, semantic memories are formed and retrieved C-consciously. Lacking the need for language, episodic memories can be stored and retrieved B-consciously. As Joseph (2008b, p 1) puts it, the two halves of the brain “may not only perceive things differently, but have different memories triggered in response to those perceptions”. The following case study is concerned with behaviour brought about by B-conscious episodic memory, in the absence of C-conscious semantic memory.

SCENARIO 2.3

When Carol was a little girl she was molested on several occasions by her uncle. The first time she was nearly 4 years old and had been sitting next to her uncle on the couch when he began to stroke and run his fingers through her hair. He continued this action while he cajoled and intimidated her into performing fellatio. He did this to her on ten or more occasions over a one year time period until he moved away. Somehow she managed to forget all about this until many years later while in college.

She was in bed with her boyfriend and they had just finished making love when he began to stroke and run his fingers through her hair. All at once she began to panic, became quite hysterical, and started crying and trying to strike her boyfriend. Then grabbing up her clothes and quickly getting dressed, she ran from his apartment.

> For the next several weeks she refused to talk to him, hung up when he called her, and began to feel an overwhelming aversion towards men. She sought counselling, but to no avail.
>
> It was only a year later while watching a movie that the entire memory of what had happened to her, so many years before, unravelled. In the movie a man walked into a crying girl's bedroom and while trying to soothe her began to brush and run his fingers through her hair. Immediately Carol began to feel angry and upset, and then she remembered. (Joseph 2008b, pp 1-2)

There can be little doubt that Carol's actions were the result of what happened to her as a four-year-old. Since her uncle's behaviour was not followed by flight, it does not seem appropriate to view her later actions as a Pavlovian response. It might be claimed that her response to her boyfriend's action was emotional, and not conscious. I will discuss right-hemisphere emotional responses in chapter 4 (section 4.3.3). Based on that analysis, getting dressed was B-conscious behaviour, which implies B-conscious reasoning and B-conscious access to the memory of her abuse.

As a four year old, Carol lacked the language to be able to store what happened as a semantic memory, with the result that it could not be recovered C-consciously. When her boyfriend's action stirred the episodic memory it was only accessible B-consciously. This explains why she could not explain her actions, even to herself. But then it appears that while watching the film – both B-consciously and C-consciously – she could form a link between the episodic experience being depicted and the semantic representation of that experience, and this provided the key to C-conscious access to her episodic memory of what had happened to her as a child. The mechanisms involved in this, and the whole issue of "repressed memories", are outside the scope of this thesis.

The significant issue is that when her boyfriend stroked her hair it triggered a memory that was only accessible B-consciously, and her subsequent actions were the result of B-conscious reasoning. She was C-conscious at the time, but both the memory and the reasoning were not C-consciously accessible.

SUMMARY: In certain circumstances we can respond B-consciously to a stimulus because of a memory that we can access B-consciously but not C-consciously. We are then unable to introspect the reasons for, or explain, our behaviour.

In the next two sections I review two experiments in which I will claim that B-conscious perception and reasoning, inaccessible to C-consciousness, provide the best explanation for the outcome.

2.3.4 Choosing and confabulating

In this section I review an experiment in which the participants were asked to choose between identical objects and, when required to explain their choice, then confabulated. I point out the similarity to the behaviour of a split-brain patient, and suggest that this is evidence of B-conscious reasoning that was inaccessible C-consciously.

Nisbett & Wilson (1977) report an experiment in which subjects were confronted with four identical pairs of stockings (laid out in a line) and asked to select the best pair (ibid, pp 243-244). Once they had made their choice, they were asked to give their reasons. In actual fact, there was a very strong bias to selecting the rightmost pair of stockings (a factor of almost four to one compared with the leftmost pair), but position was *never* spontaneously mentioned when the subjects gave their reasons. Indeed, most subjects, when subsequently questioned, denied that it played any part in their decision.

Nisbett & Wilson do not provide an explanation for this result, but one can be provided based on the existence of both B-consciousness and C-consciousness. There were no differences between the pairs of stockings by which to discriminate between them, using the data available to C-consciousness. The subjects were therefore unable to make a C-consciously reasoned decision as to the best pair, but could have made a C-conscious random selection. The fact that they did not report a random choice shows that this did not happen.

Instead, we see behaviour that is a close parallel to that reported in 2.1.6 above. In that case, a split-brain patient, whose left hemisphere does not have access to the choices made by the right hemisphere, confabulates the reasons for a choice of which he only becomes C-consciously aware after it has been made. The fact that in this latter case the participants confabulated the reasons for their choice shows that they had no C-conscious awareness of their reasoning that led to the choice, only of the result of the choice.

I suggest that the best explanation for this behaviour is that, unable to make a C-conscious reasoned choice, the selection was made B-consciously. We – like them – cannot access their B-conscious reasoning, but we can infer from the results that position played a significant role, so it was not random.

SUMMARY: In an experiment where participants had to choose between identical objects, they confabulated their reasons. The best explanation is that the choice was made B-consciously (since there was no basis for a C-conscious choice), and that unaware of the B-conscious reasoning, the Interpreter Module made up reasons.

I will turn now to a more recent study that also suggests that decisions to act may be made B-consciously when there is no basis for a C-conscious reasoned decision, and only subsequently does the result of that decision reach C-consciousness.

2.3.5 B-conscious decision making

Soon et al (2008) report an experiment in which subjects view a computer screen, displaying a letter, updated every half second. The subjects are asked to press either of two buttons (one to the left with the left forefinger, or one to the right with the right forefinger) at their own instigation. After they have pressed a button they are asked to indicate which letter was displayed when they consciously made their decision. During this whole process their brain activity is being monitored. The experimenters report that the choice of which button the subject's would press could be determined from brain activity well before the time at which the subjects reported their awareness of the decision.

The decision to press one of the buttons did not require any reasoning using the visual data available on the screen, and there was no basis for a C-conscious choice of which button to press. As in the previous case, it is not unreasonable to suppose that the decision to press a particular button was made B-consciously, and only subsequently recognized C-consciously – perhaps by detecting the bodily preparations for the movements required to fulfill the decision.

This scenario would explain how the experimenters were able to identify which button would be pressed well before the point at which the subjects reported their conscious decision. Although it is undoubtedly true that there will be brain activity that is a precursor to conscious decisions, it makes little sense to suppose that that brain activity includes the outcome of the decision – unless we are to abandon any idea of our making free choices. By recognizing that there are times when decisions are made B-consciously and are only subsequently identified C-consciously, we can retain our sense of free will and at the same time explain how the decision could be identified by brain activity prior to C-conscious awareness of the decision.

SUMMARY: In an experiment participants identified the point in time at which they had made a choice, but concurrent brain scans gave evidence of the choice significantly earlier. The best explanation is that the choice was made B-consciously, and then recognized C-consciously.

It might be claimed that focussing on experimental situations or a case of childhood trauma is a long way from making the case for two forms of consciousness existing side by side in everyday life. But sleep is part of everyday life, and in the next two sections I consider how we can distinguish between two forms of consciousness in relation to sleep. I begin with the difference between sleep and coma.

2.3.6 Distinguishing between coma and sleep

In this section I point out the significant differences between being asleep and being in a coma, although these states are often equally described as cases of unconsciousness. I will argue that the difference between them can be simply explained by the distinction between B-consciousness and C-consciousness.

In the opening chapter I made reference to Rosenthal's claim that "to be conscious a person or other creature must be awake and sentient" (Rosenthal, 1997, p 729). This, of course, implies that to be asleep is to be unconscious. Searle makes a similar point when he says that "by 'consciousness' I simply mean those subjective states of sentience or awareness that begin when one wakes up in the morning from a dreamless sleep and continue throughout the day until one goes to sleep at night, or falls into a coma, or dies, or otherwise becomes, as one would say, 'unconscious'" (Searle 2002, p 7).

I will return to Searle's point about "dreamless sleep" in the next section, but for the moment I want to focus on his claim that going to sleep, falling into a coma, and dying are all ways of ceasing to be conscious. I will show that in doing so he fails to account for significant differences between being asleep and being in a coma: differences that are easily explained by the distinction between B-consciousness and C-consciousness.

Imagine a hospital ward with two patients: one is in a coma, the other has recovered from a coma and been pronounced conscious, but is fast asleep (and not dreaming). There is clearly a difference between the two patients. If the fire alarm goes off, the patient who is asleep will wake up but the patient in a coma will remain in a coma. A person in a coma does not respond in any conscious way to external stimuli, whereas a sleeping person will respond to some stimuli, such as an alarm or a baby crying. The former is neither C-conscious nor B-conscious.

Imagine a mother who sleeps through her partner's snoring, the wind rattling the window and the birds greeting the new day in a burst of singing, but wakes up when her baby cries – even though in purely physical terms the sound of the baby is quieter than the other sounds. The discrimination between the various noises is clearly not based on their auditory characteristics, but on their significance for the sleeper. Since she cannot on wakening report the various sounds that occurred, it is clear that she was not C-conscious. Whilst some might wish to make a case that her response to the baby was "subconscious", it does not meet the criteria of higher order representation and complex reasoning required for subconsciousness, set out in chapter 1 (section 1.8.2). It does, however, meet the criteria for reasoning, and thus must therefore be classed as B-conscious.

Bear in mind that I defined creature consciousness in chapter 1 as a "capacity" to respond to the environment and to reason. The capacity can exist when there is no response to the environment and no reasoning in progress, just as a house can be connected to the power even when every appliance is turned off. So even if there is no sensory input and no thought, this is not enough to demonstrate the absence of consciousness.

SUMMARY: The best explanation of the difference between being in a coma and being asleep is that in the former case you are neither B-conscious nor C-conscious, but in the latter you are B-conscious but not C-conscious.

But being asleep is not a simple thing: there are distinctions to be made between dreamless sleep and dreaming, and between being asleep in bed and sleep walking. These distinctions will be the topic of the following section.

2.3.7 Consciousness and sleep

In the previous section I distinguished between being dreamlessly asleep and being in a coma. In this section I focus on sleep and the different states that can be part of sleep. I begin with the phenomenon of sleep walking.

> *SCENARIO 2.4*
> A man gets out of bed and while still fast asleep gets dressed, goes down stairs, walks across the living room and takes down a letter from behind the clock. He goes to the front door, puts on his coat, and goes out into the street. He checks for traffic before crossing the street and walking to the post box. Having posted the letter he returns home, gets undressed and goes back to bed.

The actions of the man in this case bear all the hallmarks of reasoned behaviour. He is able to make his way around the furniture, to recognise the letter for what it is, cross the street safely, and place the letter in the appropriate place – the post box. If it were not for the fact that he was not aware of what he was doing, and thus has no memory of doing it, we would want to say that these are all instances of reasoned behaviour. There was clearly desire (to post the letter) and belief (that the road was safe to cross, that the letter would be collected from the post box). This meets all the criteria for B-consciousness – but is clearly different from being asleep in bed.

To mark this difference I distinguish between two levels of B-consciousness: a restricted level of B-consciousness in normal sleep, and a full form of B-consciousness seen in the case of sleep walking, as well as is certain behaviours described in the earlier part of this section. A similar distinction between a restricted form of C-consciousness and its full form may account for the difference between dreaming and dreamless sleep.

During dreams there is awareness of what we are dreaming, and that can result in memories of what we dreamt. It is also known that external sounds can be incorporated into our dreams. I have clear memories of some dreams from forty or more years ago, even though I have forgotten much of my waking experience from that period. If I can introspect my dreams, or at least some of them, and can verbally report their content, then the criteria for C-consciousness have been met.

I suggest, therefore, that just as in dreamless sleep there is a limited form of B-consciousness, so during dreaming sleep there is a limited form of C-consciousness. Generally speaking, it would seem that a switch in the brain ensures that we do not physically carry out the actions that we dream. In rare cases however this limited form of C-consciousness can combine with the full form of B-consciousness seen in sleep walking. An example is a man who, dreaming that he was fighting off and strangling a burglar, actually strangled his wife to death: at his trial he was found not guilty of murder (Morris 2009).

The differences between sleep and coma, between sleep in bed and sleep walking, and between dreamless sleep and dreaming sleep, can all be accounted for by the two forms of creature consciousness, each having both a limited and a full form. The table overleaf summarises the position.

	B-consciousness		C-consciousness	
	Limited	Full	Limited	Full
In a coma	x	x	x	x
Dreamless sleep	√	x	x	x
Sleepwalking	x	√	x	x
Dreaming	√	x	√	x
Dreaming/sleepwalking	x	√	√	x
Normal wakefulness	x	√	x	√

Table 2.1 Consciousness in coma, sleep and wakefulness

2.4. Some questions and some answers

In the previous part of the chapter I have claimed that a diverse range of situations can be explained by the coexistence of B-consciousness and C-consciousness. However, despite the attraction of a common explanation, the presence of two forms of consciousness raises a number of questions, and three of these will be considered in this part.

2.4.1 Why am I not aware of both forms of consciousness?

There are two possible responses to this question. One is to say "But you are aware!" The other is to look for reasons for a lack of awareness. I will take each of these responses in turn, dealing with the first in this section and the second in the next.

There is, in fact, a long-standing awareness of the duality of the human mind. We understand someone who says "I am in two minds whether to do A or B". We say of someone else that "He does not know his own mind". One of the purposes of counselling is to bring to light memories, or attitudes, of which we are not [C-]conscious. This sense of division within the human mind was expressed two millennia ago by the apostle Paul.

> I do not understand what I do. For what I want to do I do not do, but what I hate I do. (Romans 7: 15 New International Version)

However, although this duality has long been recognised, it is usually expressed by dividing mental activities – perceiving, thinking, choosing, remembering, deciding – into those that are conscious and those that are unconscious – or sometimes subconscious. But to deny consciousness to those activities when we are not aware of them C-consciously is to deny that split-brain patients are conscious when they are using only their right hemisphere, and to deny consciousness to animals.

Nobel laureate neuroscientists such as Sperry (1981) and Edelman (2006) have no problem in claiming that humans have two distinct forms of consciousness, but philosophers either ignore or reject their claims. Even those philosophers such as Frankish who accept an essential duality in the human mind label the two divisions as ‘conscious’ and ‘unconscious’ (Evans & Frankish 2009). So there is a sense in which the two forms of consciousness are recognised, although one is mislabelled.

SUMMARY: There is a long-standing recognition in folk psychology of a duality in the human mind, but it is often explained in terms of conscious and unconscious thought and behaviour. Philosophers have largely ignored the evidence from split-brain patients for consciousness in both cerebral hemispheres.

There remains the question of why the C-consciousness located in the left hemisphere, the form of consciousness that enables us to introspect our mental states and to communicate the content of those states in language, cannot introspect and report the operations that take place B-consciously in the right hemisphere. We can understand why this does not occur in split-brain patients, but why is it true for the vast majority of us, whose *corpus callosum* is still intact? This is the subject of the following section.

2.4.2 Why cannot C-consciousness access B-consciousness?

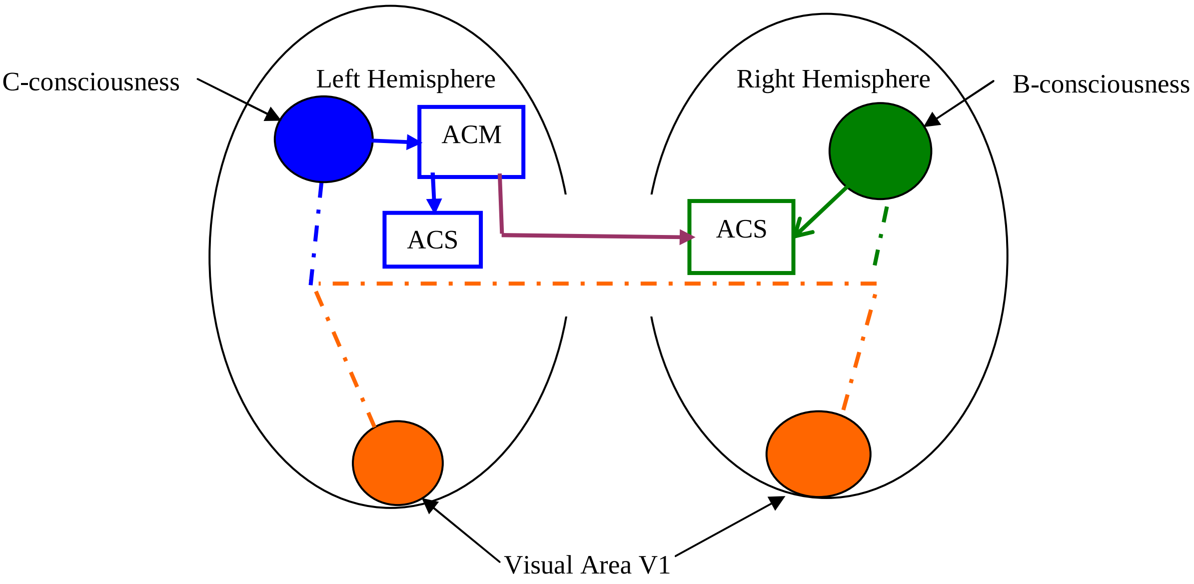
There are two levels at which this question might be answered: the theoretical and the practical. The answer at the first level can only be: because that is how mankind has evolved. The evidence cited in part 2.1 from split-brain patients reveals that there are considerable differences between the two hemispheres. Perhaps the most important is that the right hemisphere handles sensory inputs quickly, whereas the left hemisphere takes time to analyse and consider. This allows both a rapid response to circumstances such as danger, and the careful reflective analysis of circumstances that promotes learning and adaptability. A case might be made that this combination of abilities offers the best opportunity for the survival of the species.

It has been speculated that communication between the two hemispheres may be concerned more with competition than with cooperation. This is because “the processing delays inherent in transcallosal communication may limit the extent to which the two hemispheres can cooperate” (Gazzaniga et al 2002, p 416). We know that some information passes between the hemispheres, since I am C-conscious of the whole visual field – even though the left-hand half of the field was processed in the right hemisphere. But is seems that once basic sensory data has been shared between the two hemispheres, the conscious processing of that data proceeds independently.

This is why the soldier (2.3.2 above) is forced to say “I must have seen . . .” whatever it was that caused his behaviour. He did not have C-conscious access to the reasoning that had led to the action. In his case his assumption was correct, but in the experiment reported by Nisbett and Wilson (2.3.4 above) the inability to access the reasoning behind their actions caused the participants to confabulate.

SUMMARY: There are two levels of processing in each hemisphere. The output from the lower level is shared with the other hemisphere via the *corpus callosum*, but the output from the higher level of processing remains within each hemisphere (see figure 2.3 below).

The following diagram provides a highly simplified illustration of the relationship between the two hemispheres, and the two levels of processing. It will be expanded in chapter 3 to take account of divisions within the visual system.



Orange – processes shared between hemispheres
Blue/Green – processes limited to one hemisphere
Purple – commands from ACM to right hemisphere ACS

ACM – Action Command Module
ACS – Action Control System

Figure 2.3 Inter- and intra-hemispheric processing (simplified)

2.4.3 How do split-brain patients lead a normal life?

As I mentioned above, the initial and surprising evidence from patients whose *corpus callosum* had been severed is that, after a recovery period of between six and twelve months (Sperry 1981, p 2), they are able to lead an apparently normal life. The key, I suggest, lies in the cooperation between two centres of consciousness.

During the recovery period the C-consciousness in the left hemisphere is faced with the fact that it only has control of the right side of the body: the link from the Action Command Module to the Action Control System in the right hemisphere (that controls the left hand side of the body) had been severed. It is possible that some information can pass between the hemispheres via the brain stem and associated areas to which both hemispheres remain connected, but this route in not adequate to support the amount of correlation needed for tasks such as walking.

We can assess the possibility of cooperation between two independent centres of consciousness – each controlling one half of the body – from the experience of the Hensel twins (Haywood, 2009). Abigail and Brittany are conjoined twins, with two heads linked to a composite body with separate spines, hearts, lungs and stomachs in the upper abdomen, but shared organs below that level. They have two arms and two legs, with one of them controlling the left arm and leg, and the other the right arm and leg. By cooperation they are able to swim, ride a bike, and join in sports activities. They have together passed their driving test.

If two separate minds/brains can cooperate to this extent, then it is not surprising that two centres of consciousness in one divided brain can cooperate and enable the individual to live a relatively normal life.

SUMMARY: The behaviour of dicephalic conjoined twins provides an example of how two separate centres of consciousness, each able to control only half of the body, can combine to produce unified behaviour.

2.5 Summary

In this chapter I have set out the evidence for two separate centres of consciousness – one in each hemisphere – in humans. I have drawn on detailed studies of individuals whose *corpus callosum* has been severed to show that each hemisphere is conscious, and that there are significant differences in cognitive abilities between the two hemispheres. Evolutionary evidence shows that mankind inherited a basic form of creature consciousness from its animal forebears, and that this was supplemented by the development of a more complex form of creature consciousness during human evolution. Using criteria set out in chapter 1, I identified the consciousness located in the right hemisphere as B-consciousness, and that located in the left hemisphere as C-consciousness.

In the third part of the chapter I reviewed a variety of circumstances in which the presence of these two centres of consciousness provides the best explanation for observed human behaviour. As well as experimental situations, the circumstances discussed include driving on automatic pilot and sleepwalking. The difference between sleep and coma, and between dreamless sleep and dreaming, can also be explained by the two centres of consciousness.

I suggested that there is a tendency to limit creature consciousness in humans to what I have termed C-consciousness – which includes the ability to introspect our mental states and to report on those states verbally. This results in classing any behaviour that cannot be introspected or reported as either unconscious or subconscious. The implications of this action is to deny consciousness to animals – since we have no evidence that they can introspect their mental states and report their content using language – and to split-brain patients using their right hemisphere.

I conclude that the evidence for the presence of two forms of creature consciousness in humans – B-consciousness in the right hemisphere and C-consciousness in the left hemisphere – is at least very strong, if not irrefutable. Philosophical theories of consciousness that fail to account for this duality require revision.

In chapter 4 I will consider the implications of the duality of consciousness for our understanding of visual perception, and in chapter 5 I will list some other areas where standard philosophical views require amending. Before that, I focus in chapter 3 on another example of duality in the human mind/brain – the two cortical visual pathways.

CHAPTER 3

THE TWO CORTICAL VISUAL PATHWAYS

In this chapter I review some of the empirical evidence that has amassed in recent years about the two ***cortical*** visual pathways in humans, and discuss the relationship between these pathways and consciousness. I begin with a brief review of how the understanding of the role of the two pathways has developed, before outlining some important distinctions that are necessary before the empirical evidence can be properly assessed. I then describe some of the experiments that have been taken to throw light on the differences between the two pathways, and assess some challenges to those conclusions. The central issue to be addressed is how these two distinct pathways interact with the two forms of creature consciousness which I defined in chapter 1, and for which I provided evidence in chapter 2.

3.1 An introduction to the two pathways

In this part of the chapter I summarise the steps that led to the identification of two distinct visual pathways[1] and the changing understanding of their role. I review an early animal experiment, and examine two cases of neurological deficit in humans that illustrate the difference between the two pathways. I end this part by drawing some preliminary conclusion about the relationship between the pathways and human consciousness.

3.1.1 The historical background

Neurological studies on primates some 40 years ago revealed the presence of two distinct cortical visual pathways. The pathways are distinguished by both route (see figure 3.1 overleaf) and purpose. Both start from the primary visual area (V1) in the ***occipital lobe*** at the rear of the brain: one pathway terminates in the ***parietal lobe***, and is usually known as the "dorsal pathway"; the other terminates in the ***temporal lobe***, and is usually known as the "ventral pathway" (Gazzaniga et al 2002, p 160). There are interactions between the two pathways, especially in regards to the area that analyses movement.

The names "what" for the ventral pathway, and "where" for the dorsal pathway were initially coined by Schneider (1969), proposing that the former showed what was being seen, and the latter where it was located (cited in Goodale & Milner 1992, p 20).

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[1] The term 'pathway' was used by Goodale and Milner (1992) when they first proposed the dichotomy in the human visual system. Since then much of the literature has used the term 'stream'. I will use the former term, but it should be clearly understood that both terms refer to the same feature of the human brain.

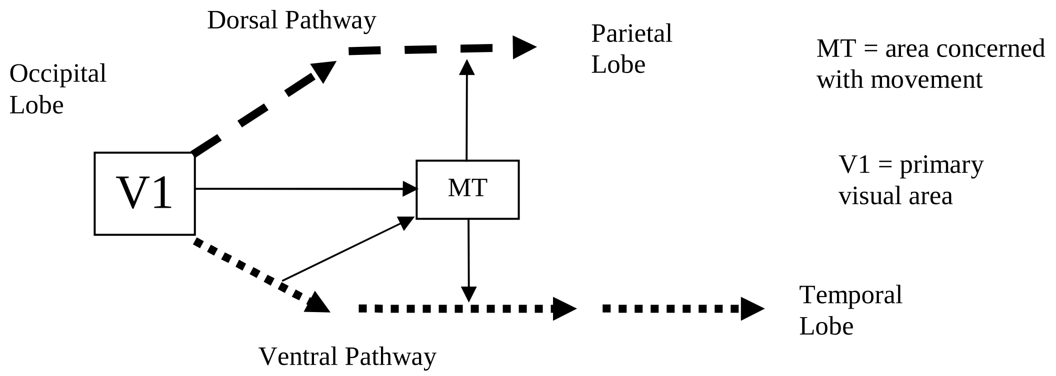

Figure 3.1 Two visual pathways in the human brain (highly simplified)

When Goodale and Milner proposed that a similar distinction could be identified in humans, they claimed that the latter pathway is concerned not so much with where an object is located as with the control of actions in relation to that object, and introduced the terms "for perception" and "for action" to distinguish the role of the two pathways.

The more commonly used terms now are the "visuoperceptual" and the "visuomotor" pathways (see for example Radoeva et al 2005). These terms reflect the fact that the ventral pathway enables us to identify what we see, to think about it, and to report it linguistically; whereas the dorsal pathway provides the information to control our actions in respect of what we see. This distinction is clearly shown in an experiment carried out by Goodale and two colleagues (Aglioti et al 1995). In a case of visual illusion, perceptual judgments were affected by the illusory size of objects, but grasping was related to actual size. (I will return to the issue of illusion below.)

The evidence on which Milner and Goodale relied in the early 1990s was largely the neurological findings from primate studies and various dissociations in human visual abilities arising from brain damage. However, writing some 20 years later they were able to report that:

> The fact that much has happened since 1994 means that the story has become more complex, but we believe that the idea of a fundamental distinction between perceptual representation and visuomotor control is still essential to understanding the organization of the [human] visual system. Indeed, new findings, particular from functional MRI (fMRI), have strengthened the evidence base for this two-stream model of visual processing. (Milner & Goodale 2006, p 207)

SUMMARY: Animal experiments in the 1980s revealed two visual pathways. Combining this evidence with cases of neurological deficit in humans, Milner and Goodale claimed that there are two visual pathways in humans – one for perception and one controlling actions. Recent developments in neuroimaging have confirmed their claim.

There continue to be disagreements about whether particular visually-related behaviours are associated with one or the other pathway, and some of these will be discussed in parts 3.2 and 3.3. Before that, I continue in this part to review some of the historical data that led to the identification of the two pathways in humans.

3.1.2 The pathways distinguished in primates

A 1973 animal experiment, in which three groups of rhesus monkeys were trained to identify the location of food, highlighted the different role of the two pathways (Gazzaniga et al 2002, pp 196-197). One group of monkeys had both parietal lobes ablated (the termination of the dorsal visual pathway), and another group had both temporal lobes ablated (the termination of the ventral pathway). The animals comprising a third, control, group were left untouched.

THE TEST

In the experiment the monkeys had to learn to recognize which of two bowls contained food. In one case, the location of the food was indicated by whether or not a marker was located beside the bowl containing the food: this “landmark” test was designed to use the dorsal visual pathway. In the other case the location of the food was indicated by which of two different objects was located beside the bowl containing the food: this “discrimination” test was designed for the ventral pathway.

In the landmark test the monkeys were first trained to identify the presence of food by the location, next to the dish with the food, of a small cylinder, with the food and cylinder randomly moved between the left and right dishes. Once they had learned to so do, they were then trained to identify the location of the food in the dish not adjacent to the cylinder. Once this was achieved, training reverted to the previous case, and so on, until seven cycles of training had been completed.

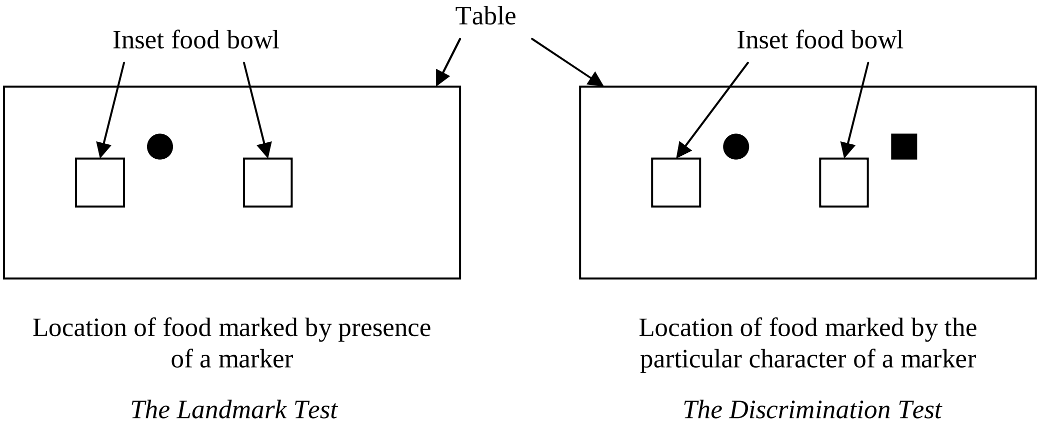

Figure 3.2 Testing the visual pathways in rhesus monkeys

A similar pattern was followed for the discrimination test, except that the location of the food was marked by the presence of either a small cylinder or a small cube next to the dish with the food in. The position of the food and the two markers was randomly changed, and once the monkeys had learned to associate food with one of the markers, they were then trained to associate it with the other marker: again for seven cycles.

Success in each cycle of the test was set at 28 correct choices of the bowl containing the food in thirty attempts, and the number of errors prior to success was recorded.

THE RESULTS

Iteration	Landmark Test			Discrimination Test	
	Dorsal Path Intact	Ventral Path Intact	Both Paths Intact	Dorsal Path Intact	Ventral Path Intact
Opening	180	140	160	140	>10
Cycle 1	300	220	200	140	>10
Cycle 2	140	220	100	110	>10
Cycle 3	100	210	90	50	>10
Cycle 4	90	190	40	60	>10
Cycle 5	80	200	50	30	>10
Cycle 6	70	180	30	40	>10
Cycle 7	70	160	20	20	>10

Table 3.1 Number of errors prior to success by Visual Path in Tests on Rhesus Monkeys (figures rounded to nearest 10)

The landmark test was taken by all three groups, and all three made between 140 and 180 errors before success on the first presentation of the test. All three groups made over 200 errors before learning that the food was now in the bowl without a marker. From this point on, the group with their parietal lobe ablated (using their ventral pathway) made only marginal improvements, still making over 150 errors before success on the seventh cycle. By contrast, the control group and the group with their temporal lobe ablated (using their dorsal pathway) improved their performance significantly at each cycle of the test, making significantly fewer errors before success. It should however be noted that the control group, making use of information from both pathways, outperformed the group using only the dorsal pathway.

The control group did not take part in the discrimination test, which showed a significant difference between the other two groups. The group with their dorsal pathway intact did improve their performance with each cycle of the test, with the number of errors reducing from around 140 to less than 20. However, the group with their ventral pathway intact succeeded from the very first cycle with less than ten errors, and by the fifth cycle needed only two or three errors before achieving success.

THE CONCLUSIONS

Monkeys with both pathways intact outperformed both other groups in the landmark test, suggesting that the combination of information from both pathways is more powerful than the information from one pathway, even though it is specialised. Unfortunately, the control group did not take the discrimination test, so we cannot assess the benefit of utilizing both pathways for object discrimination.

Monkeys with an intact ventral pathway had no problems with the discrimination test, but performed very badly in the landmark test. This is strong evidence for the ventral pathway being specialized for object discrimination.

Those with an intact dorsal pathway outperformed those with an intact ventral pathway in the landmark test, providing evidence that the dorsal pathway is specialised for identifying the location of objects, and not the differences between them. But although the former group did significantly less well than the latter in the discrimination test, they did nevertheless show a marked improvement over the seven cycles.

One possible explanation for this result is that the test can be treated as a landmark test. Instead of distinguishing between the cylinder and the cube to determine the location of food, perhaps this group of monkeys focused instead on the cylinder – as in the first test – and its location (since if the food was in the bowl marked by the cube, then it was not in the bowl marked by the cylinder).

Two important points need to be made about the results of this experiment. The first is that in the course of human evolution there has occurred the specialization of the two cerebral hemispheres. It would not be surprising if this resulted in some changes to the visual system inherited from our primate ancestors, and it probably explains a change in the role of the two pathways. In humans, the ventral pathway is specialized for object discrimination, identification and classification, and the dorsal pathway for the control of actions in respect of objects. This difference will be explored in the following section.

The other point to note is that the monkeys' behaviour provides clear evidence of perception and reasoning, and therefore of consciousness, using both of the visual pathways. As will be seen below (section 3.1.4), the situation is different for humans. In the following section I begin to consider the role of the two pathways in humans in more detail.

SUMMARY: Tests on rhesus monkeys revealed clear differences between the two visual pathways. However, later evolutionary changes in humans, resulting in the specialization of the two cerebral hemispheres, mean that the role of the pathways will have evolved.

3.1.3 Two cases of neurological deficit

Goodale and Milner (1992) drew on two forms of neurological deficit – optic ataxia and visual form agnosia – to support their initial claim for two visual pathways in humans. The presence of the two pathways is now well-attested by neuroimaging studies, and these cases are now more illustrations of the role of the two pathways than proofs of their existence. In this section I review the evidence originally cited by Milner and Goodale, and two recent challenges to their conclusions.

Optic ataxia is a loss of control of eye movement that follows damage to the posterior parietal region (associated with the dorsal visual pathway). Such patients have no difficultly in recognising objects (which makes use of data from the ventral pathway), but are unable to reach accurately for them (Goodale & Milner 1992, p 21). Their problem is not only in reaching in the right direction, but also in positioning their hand and fingers to the right size and orientation to grasp the object.

The converse situation is demonstrated by patients whose ventral pathway has been damaged, and thus suffer from visual form agnosia. One such sufferer, DF, had damage to the ventral visual pathway as a result of carbon monoxide poisoning (ibid, p 22). She showed significant problems in identifying objects, being unable, for example, to distinguish between two blocks of different sizes. One experiment made use of a block of wood with a slot in it, that could be rotated at will. When asked to indicate the angle at which the slot was positioned with her hand, she could not do so, but when a card was placed in her hand she could post it through the slot without any problem.

OBJECTION

In a subsequent paper Milner and his colleagues (Milner et al 1999) showed that a patient with optic ataxia performed better if vision was disabled prior to reaching and grasping, because, it was assumed, this forced them to use the stored data from the ventral pathway (see 3.2.2 below). This finding was taken to support the earlier claim of a distinction between the two pathways, but it has been challenged by Himmelbach et al (2009), who compared actions by an optic ataxia sufferer (IG) with the same actions performed by healthy subjects, using neuroimaging to reveal activation in the parietal lobe, parts of which were damaged in the case of IG. Their conclusion is that “the dorsal stream is not only essential for immediate but also for delayed movements” (ibid, p 1516).

REBUTTAL

I believe their conclusion to be flawed because it relies on an unstated – and false – premise. In part 3.2, I will make a distinction between those processes that are *part of* the dorsal pathway, and those that are *served by* the dorsal pathway. The areas of the parietal lobe activated in Himmelbach et al’s experiment are areas that play a role in planning and controlling movement, and may make use of the visual representation formed by the dorsal pathway: they do not, however, form part of that pathway. Just because a housing estate is served by a particular road, the fact that traffic is moving within the housing estate provides no evidence that traffic is also moving on that road. The fact that areas of the parietal lobe were active does not prove that the dorsal pathway was active. I will return to this issue in parts 3.2 and 3.3.

OBJECTION

Goodale & Milner claim that DF uses a visual pathway to post a card through a slot that is distinct from the pathway that underlies perception – the dorsal and ventral pathways respectively. This claim is challenged by Mole (2009) on philosophical, not empirical, grounds. One of the distinguishing features of the two pathways, it is claimed, is that we are conscious of the output from the ventral pathway, but not of the output from the dorsal pathway. Some commentators have taken this to mean that visually guided actions are controlled by a “zombie within” (Clark 2007, Koch and Crick 2001).

Mole (2009) raises objections to this approach and claims that the sort of behaviour shown by DF "can be accommodated without accepting anything like the zombie-action story" (ibid, p 995). He claims that "movement control and conscious experience are the work of *one and the same system*" (ibid, p 1002 – italics in original), and that information about what we see is stored as "an embodied demonstrative" (for example, "the slot is angled *this way*"). His argument is that DF has a deficiency in her visual system that prevents her from passively experiencing form. One example of this deficiency is that she can tell that a grey patch is striped, but cannot tell in which direction the stripes run (ibid, p 1004-1005). She cannot experience some aspects of what she sees, says Mole, until she acts in respect of those aspects. Mole's view is that "when she is acting, but only then, the forms of the things acted upon do figure in her conscious experience" (ibid, p 1005).

REBUTTAL

I reject Mole's claim on two counts. The first is that he appears to be confusing proprioceptive input with visual input. If it is true that DF gains information about objects when she acts in relation to them, then that information would appear to arise from her awareness of her bodily movements and not from the processing of data from the optic nerve.

My second objection is that whilst Mole is ostensibly arguing against there being two visual systems, his real target is the claim that there is a zombie within that controls actions towards objects of which there is no conscious experience. As will become clear in the course of this chapter, there is no need to envisage a zombie within us to explain how reaching for objects makes use of visual information that does not reach consciousness. There is therefore no need to accept Mole's convoluted explanation of DF's behaviour, especially since that behaviour can be seen as an illustration of the distinction between the pathways and not as proof of the distinction.

SUMMARY: Milner and Goodale used the different behaviour of two patients, one with damage to the dorsal pathway and the other with damage to the ventral pathway, to support their claim for the distinctive role of each pathway. Objections have been raised to their conclusions, but these can be rebutted.

DF's behaviour as described above provides evidence for an important conclusion about the relationship between consciousness and vision. I will explore this issue in the following section.

3.1.4 Consciousness and the two visual pathways

In this section I use DF's behaviour in respect of the slot to draw some initial conclusions about the relationship between consciousness and the visual pathways. These conclusions will be supported by further evidence from more recent experiments on the effect of illusion on grasping objects.

The immediate intent of DF's attempt to indicate the orientation of the slot by the position of her hand was to answer the question put to her ("how is the slot angled?"). This action involves the reporting of her perceptual experience, and – as discussed above – such actions involve the ventral visual pathway. The fact that DF failed to indicate the orientation of the slot is significant because a person with an undamaged ventral pathway would succeed. This leads us to conclude that in the undamaged brain the output of the ventral pathway reaches C-consciousness.

We know that an action such as posting a card through the slot involves the dorsal pathway, and can judge that her success in posting a card through the slot arises from the fact that her dorsal pathway is undamaged. However, her inability to draw on that pathway to report the position of the slot, in the absence of data from the ventral pathway, confirms that the output of her dorsal pathway is not available to C-consciousness. Although it is possible that the brain damage which she sustained prevented C-conscious access to her dorsal pathway, the more likely conclusion – which will be borne out by further evidence to be discussed below – is that humans in general do not have C-conscious access to the output of the dorsal pathway.

If the dorsal pathway in the left hemisphere does not reach C-consciousness, the question arises as to where it does terminate. In a paper to which I will return below, Gonzalez et al (2006) conclude that there exists a module in the left hemisphere that is specialised for visual control of action (regardless of handedness). This is the module which was referred to in section 2.1.3, to which I gave the name Action Command Module (ACM). Since the dorsal pathway is specialised for visual control of action, that pathway must serve the ACM. If decisions to act are taken C-consciously, as surely they must generally be, but the implementation of that decision is controlled by the ACM and the output of the dorsal visual pathway, then commands must be passed from C-consciousness to the ACM and control then pass from C-consciousness to the ACM, and from the ACM to the specialized action control systems (ACS) in each hemisphere.

I pointed out above that primates have conscious access to both the dorsal and the ventral visual pathways, and I will assume for the time being, pending evidence to the contrary, that B-consciousness in the right hemisphere of humans is served by both pathways. If this is so, there is a question about DF's successful posting of the card (and other actions that depend on the data from the dorsal pathway). Did DF initiate the action of posting the card C-consciously, or did she act B-consciously?

We do not know that DF was visually unaware of the presence of the slot, only that she was not conscious of the orientation of the slot (compare the example of stripes on a grey background mentioned earlier). If DF were aware of the presence of the slot, there is no difficultly in assuming that she could make a C-conscious decision to post a card through it. However, if she were not aware C-consciously of the presence of the slot, it is difficult to see how she could make a C-conscious decision about the slot, although it is theoretically possible that DF's action in posting the card through the slot was initiated B-consciously.

The evidence from brain-damaged patients that will be reviewed in the next part of the chapter strongly suggests that the former scenario is the correct interpretation of DF's behaviour. That is, that she had C-conscious awareness of the presence of the slot, although not of its orientation, and was thus able to make a C-conscious decision to post the card, and that decision passed to the ACM, where the action could draw on the data available from the dorsal pathway.

The tentative conclusion that can be drawn from the case of DF is that in the left hemisphere only the ventral pathway serves C-consciousness, whilst the dorsal pathway serves a specialized Action Control Module. The evidence from animal studies suggests that in the right hemisphere both pathways serve B-consciousness. Figure 3.3 summarises the position.

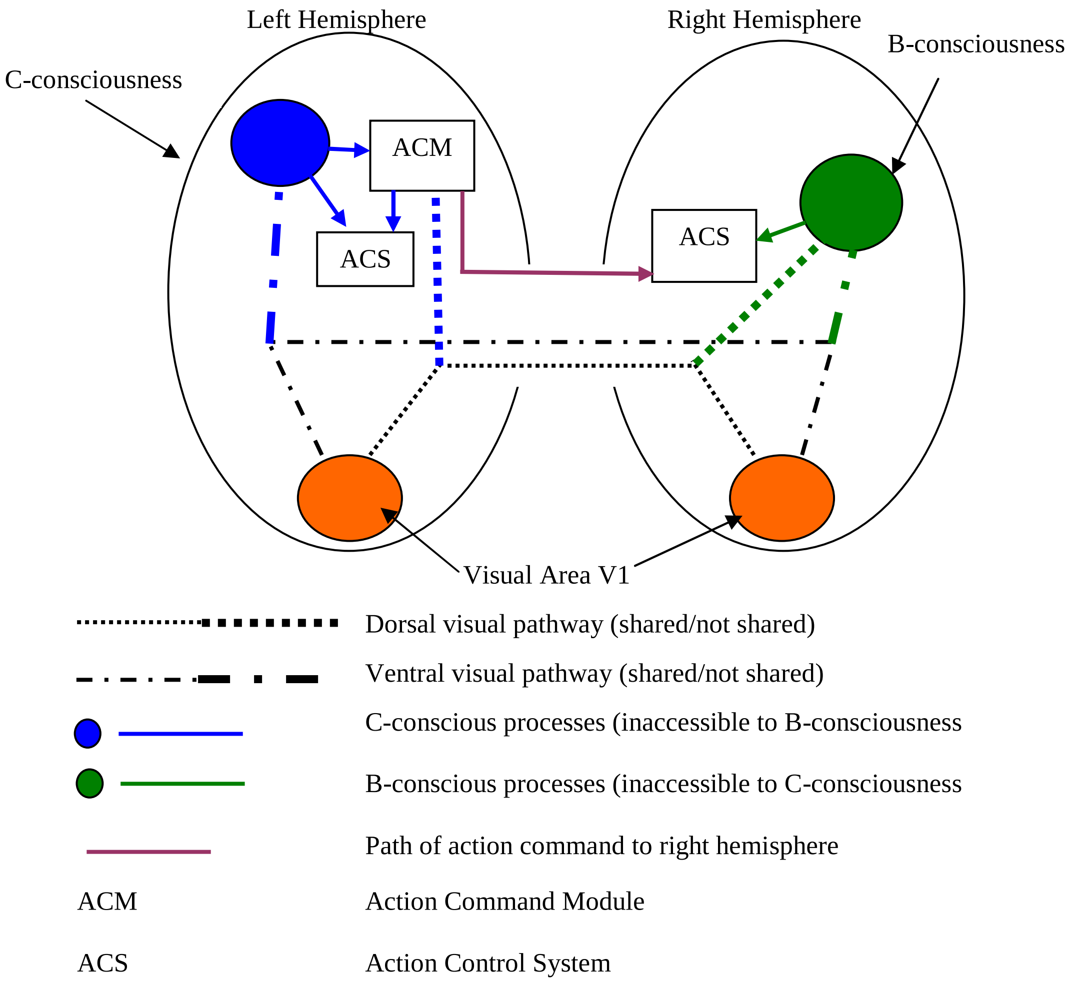

Figure 3.3 The visual pathways and consciousness

SUMMARY: Based on DF's behaviour I conclude that in the left hemisphere the ventral pathway serves C-consciousness, but the dorsal pathway terminates in a specialised module for action command and does not reach consciousness. In the right hemisphere it appears that both pathways may reach B-consciousness.

Further evidence in support of this arrangement will arise in part 3.3, but before then I need to consider some of the problems that arise in understanding and interpreting the information about the two pathways.

3.2 Resolving some problems

In this part of the chapter I review a number of problems that arise in understanding the differences between the two pathways, and in relating particular behaviours to a specific pathway. I begin with the differing requirements for the representations formed by each pathway.

3.2.1 Representations in the two pathways

Arising from the difference in their function, it is widely assumed that the data provided by each pathway will also differ in both content and form (see Clark 2009, p 1461). In this section I will outline the reasons for those assumptions, and discuss one specific challenge.

For me to identify an object on my desk as a book (which presumably requires a comparison between the visual representation of the object in view and a stored representation of what a book looks like), precise details of its size and orientation are not only not necessary – they are irrelevant to that identification. But if I want to pick the book up, then size and orientation are critical. Some idea of how visual data in the two pathways might be constructed in different ways to suit the two different purposes can perhaps be gained by comparing the two different ways in which visual information can be stored on a computer.

Many picture file formats are based on a raster image, in which the area to be depicted is divided into a grid, and information is stored about the colour of each element of the grid. Whilst the size and orientation of objects within the area will be reflected in the information stored in respect of each element in the grid, they are not specifically encoded: they must be calculated from the information stored in the file, and the accuracy of that calculation will depend upon both the fineness of the grid and the availability of clues.

Judgments about the size of the items in the picture below (Figure 3.4) are made based on our experience of bathroom furniture, and comparisons between the individual items. But a very different judgment emerges if the picture is expanded to provide more clues (see Figure 3.5 on the following page).

Figure 3.4 A bathroom set

Other picture file formats use a vector image, in which each element in the picture is described precisely (“start from **x**,**y**; draw a straight line angled **a** from vertical/draw an arc of an ellipse centred on **e**,**f**; length **l**; from **x**,**y** draw . . ."). In this format, size and orientation are among the actual data stored.

Figure 3.5 Doll's house bathroom set

These differences between two picture file formats suggest how there could be a difference between the representations formed in the ventral pathway and those formed in the dorsal pathway. Such a distinction would be consistent with the evidence that we assess size and orientation on the basis of the representations formed by the ventral pathway and can be misled by illusions, but that size and orientation are accurately represented in the dorsal pathway (Aglioti et al 1995). Evidence in support of this conclusion will be found in part 3.3.

There is another distinction that is made about the representations in each of the pathways. It has been claimed that information in the ventral visual pathway is coded allo-centrically, and that information in the dorsal path is coded egocentrically (see, for example, Jacob & Jeannerod 2004, p 103; Aglioti et al 1995, p 680). This distinction is challenged by Bermúdez (2007), who claims that 'right' and 'left', for example, relate objects to the viewer or to some "prominent landmark" (ibid, p 4), and not to each other. He claims therefore that both pathways code visual data egocentrically.

I suggest that Bermúdez is mistaken, and that it is not necessary to assume a prominent landmark before objects can be located allocentrically. Many objects in the world have a front and a back, which determine their right and left. The right hand page of a book, for example, remains the right hand page both for the pupil who is reading from it in the usual way, and for the teacher who is reading it upside down. It is the relationship between objects, rather than between individual objects and the observer, that is stored in the ventral pathway, and that relationship remains constant when I move. But for me to be able to grasp an object, it is necessary that its location be stored in relation to where I am, and that information will change dynamically as I move.

SUMMARY: Despite objections raised by Bermúdez, there are good grounds for assuming that the representations formed by the two visual pathways differ both in the information they encode and the reference system (allocentric or egocentric) used to encode it.

There are a number of other important issues about the pathways that need to be clarified before the large volume of experimental data about them can be assessed, and before the relationship between vision and consciousness can be determined. In the following three sections I highlight some important distinctions about the form and role of the two visual pathways, and the misunderstandings that can arise if they are overlooked. I begin with a distinction between two types of visual processing.

3.2.2 Distinguishing visual pathways from later processes

The visual pathways form part of the visual system, that is, those areas of the brain that process the input from the optic nerve and together form the visual representations needed for perception and action. Thus, for example, the processing of colour in brain area V4 is part of the ventral pathway, but face recognition in brain area FFA (***fusiform*** face area) is *served by* the ventral pathway but is not *part of* that pathway. The former area contributes to the formation of the ventral pathway's visual representation, whereas the latter makes use of that representation.

DISTINCTION 1: There are processes that form *part of* a visual pathway and processes that are *served by* a visual pathway.

The dorsal pathway terminates in the parietal lobe, and the visual representation that it produces is specialised for the control of movement in respect of objects. Within the parietal lobe is an area involved in the planning and execution of movements (see Connolly et al 2003). But this is an area that is *served by* the dorsal pathway, but may also be served by the ventral pathway (see Distinctions 3 below). Evidence about activity in this area cannot be taken to provide evidence about the dorsal pathway itself.

3.2.3 The visual pathways and C-consciousness

Milner & Goodale (2006) make the following claim about the two pathways:

> [T]hey . . . have different temporal characteristics. The dorsal stream may enable us to reach out and grasp objects with exquisite ease, but it appears to be trapped in the present. Acting alone, the system can deal only with objects that are visible when the action is being programmed. . . . The ventral stream, in contrast, allows us to escape the present, and bring to bear visual information from the past.
> (Milner & Goodale 2006, pp 245-246)

The inaccessibility of the dorsal pathway to [C-]consciousness has led some commentators to describe actions that draw on its output as being performed by "a zombie within" (Clark 2007, Koch and Crick 2001). This attitude has not been helped by Goodale entitling one of his papers *Action without perception in human vision*

(Goodale 2008). This is highly misleading, and contradicts the emphasis in Milner & Goodale (2006, p 221) on the role of perception in initiating action. It is, I think, clear that, with the exception of reflexes, the normal process in humans is perception → reasoning → decision → action. The action stage can be broken down into at least three steps: strategic planning (what object? what action?), tactical planning (how?) and performance. The first of these necessarily involves consciousness and thus draws upon the ventral pathway.

DISTINCTION 2: The output of the ventral pathway reaches C-consciousness, but the output of the dorsal pathway does not[1]; the former can be remembered, but the latter cannot and is only available so long as vision is enabled

There must then come a point at which that conscious decision and strategic planning, based on the allocentric representation formed by the ventral pathway, is transmitted to a module that can link that allocentric data to egocentric data provided by the dorsal pathway – subject to some exclusions which will be outlined below. I take it that the module concerned is the Action Command Module (ACM). In normal circumstances the action specified can then draw on the specialized spatial data of the dorsal pathway which serves the ACM. To suggest that such actions occur without perception, or are the responsibility of a “zombie within”, is highly misleading.

However, the view that actions are decided using the output of the ventral pathway and then carried out using the output of the dorsal pathway, whilst true in most circumstances, is an oversimplification, and has led to considerable confusion about experimental results.

3.2.4 Actions that use the ventral pathway

Actions can be divided into two categories: those that by their nature depend upon the ventral pathway, and those that are naturally dependant on the dorsal pathway (so long as that pathway is available). The different routes to action can be shown in general terms in the diagram overleaf.

DISTINCTION 3: Actions such as reaching and pointing that utilize data from the dorsal pathway must be distinguished from similar actions that utilise data from the ventral pathway even when data from the dorsal pathway is available.

There are at least three different circumstances in which action is directly consciously controlled, so that spatial information during performance of the action draws on the ventral pathway, despite the availability of data from the dorsal pathway. I will outline each of these in turn.

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[1] The justification for this distinction was outlined in section 3.1.4.

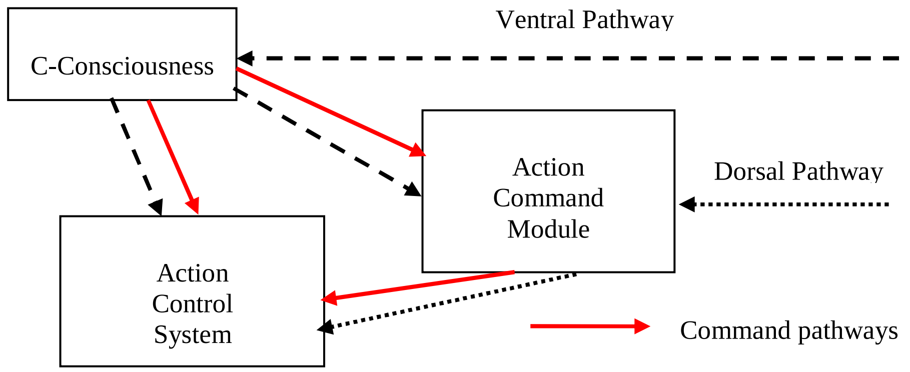

Figure 3.6 Two routes for action in the left hemisphere of the human brain

CASE 1: Quasi-linguistic behaviour

Quasi-linguistic behaviour is behaviour that can be understood as making a linguistic statement, such as nodding to mean "yes". When someone acts in a way that relates to an object, such an action may be quasi-linguistic, or it may be non-linguistic, or a combination of both. If I ask my wife "where are the keys?" she could (a) simply point to them, or say "there" and point to them, and in either case the action of pointing would be quasi-linguistic; or she could (b) say "here" and pick up the keys, in which case her action in picking up the keys would be non-linguistic, but her holding out of the keys would be quasi-linguistic. The critical test in such cases in the immediate intent of the action: when she pointed at the keys, her immediate intent was to give me information about the keys in response to my request; but when she picked up the keys her immediate intent was to pick them up (in order then to be able to respond to my question).

When quasi-linguistic acts involve the reporting of one's perceptual experience and perceptual judgments they draw on the output of the ventral pathway. This fact is extensively used in experiments designed to differentiate the role of the two pathways. If participants are asked "how wide is that object?" and they respond by opening their thumb and first finger to indicate the width, then that action is a quasi-linguistic act, and will draw on the ventral pathway. However, if they use their thumb and first finger to actually grasp the object, then under normal circumstances they are drawing on the dorsal pathway – so long as the object to be grasped remains visible (see below).

CASE 2: Non-existent target

The second situation in which action must rely on the ventral pathway is when the target of the action is a calculated location and not an object. If there is no object, there can be no representation of the position of that object in the dorsal pathway. If I am asked to move my hand to a position that shows where an object will or would be given certain assumptions, then I must perform conscious calculations which must draw on the ventral pathway.

Melmoth et al (2009) claim that the Poggendorff illusion (see figure 3.7 below) affects equally the output of both visual pathways.

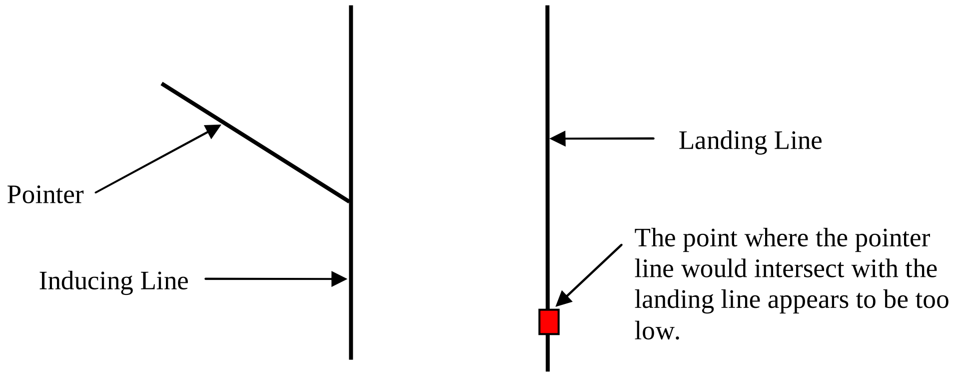

Figure 3.7 The Poggendorff Illusion

In an experiment, participants had to indicate where the pointer line would intersect with the landing line, (a) by moving a marker or (b) by rapidly pointing to the position. They assumed that the former task would use data from the ventral pathway, and the latter task would use data from the dorsal pathway.

But since the pointing is to a location that has to be calculated, and not to a visually-represented target, this action must draw on the same pathway – the ventral – as the perceptual judgments, and thus both cases would be affected by illusion to the same extent.

CASE 3: Awkward or unpractised movements

The final class of action which involves the ventral and not the dorsal pathway is composed of those actions that require awkward or unrehearsed movements. When a cricketer is in form he makes a conscious decision of where to hit the ball, but the detailed planning and execution of the stroke require no conscious involvement and draw on the dorsal pathway. When he is out of form, however, he must consciously think “I must move my left foot to there; I must angle the bat just so; I must swing the bat in this direction”, and his actions therefore draw on the ventral pathway.

In an experiment reported by Gonzalez et al (2008) participants were asked to grasp an object in an illusory setting using thumb and first finger or thumb and ring finger. The former action was not affected by the illusion, but the latter was. However, after three days of practice using thumb and ring finger of their right hand to grasp the object participants were no longer affected by the illusion, although those using their left hand continued to be affected. This provides strong support for the presence of the Action Command Module in the left hemisphere, and suggests that when there is no schema for an action already stored in memory, then the ACM cannot match the data in the dorsal pathway with the data in the schema, and the action must be consciously controlled, using the data available from the ventral pathway, until a schema is created.

In addition to these three categories of action that draw on the ventral pathway, there is one other situation in which the ventral pathway comes into play. Milner & Goodale (2006, p 246) say of the dorsal pathway that "the system can deal only with objects that are visible when the action is being programmed" (what I have termed "strategic planning"). I will show later that the evidence indicates that the final six words of this claim should be deleted: that is, the dorsal pathway is only available to guide grasping whilst vision is enabled, at whichever stage vision is disabled (see 3.3.4 below). When the dorsal pathway is not available, data must be drawn from the ventral pathway.

SUMMARY: There are four circumstances in which the performance of an action draws on the spatial data in the ventral pathway and not on the data from the dorsal pathway:

1. When the action is quasi-linguistic;

2. When the action relates to a calculated target point where there is no object;

3. When the action involves awkward and/or untrained movements;

4. Where the target object becomes invisible after a decision to act has been made but before the action is completed.

These categories will prove important in the next part of the chapter, when I review recent experiments concerning the role of the two pathways.

3.3 Illusion and the two visual pathways

There have been many experiments in recent years that rely on the claim that indicating the size of an object with the thumb and forefinger (often referred to as "estimating") draws on the ventral pathway, whereas actually grasping the object draws on the dorsal pathway, provided that vision is not disabled before planning of the grasping movement has been completed. There are, however, exceptions to this simple dichotomy, as explained in the previous section. Care must be taken in setting up and drawing conclusions from such experiments, to ensure that behaviour is attributed to the correct pathway.

As mentioned in 3.1.1 above, it has been shown that when faced with a size illusion, perceptual judgments of size are affected by the illusion, whereas grasping movements are mainly affected by actual size (Aglioti et al 1995). In this part of the chapter I review a number of other experiments that made use of illusory settings. In several of these experiments, reported recently, vision was disabled at various points between the planning of the grasping movement and its completion. The results of these experiments have been claimed to deny the distinction in the roles of the two pathways, but I will argue that – correctly interpreted – they in fact support the distinction.

3.3.1 Estimating and grasping – the Müller-Lyer Illusion

An experiment reported by Radoeva et al (2005) included some brain damaged patients, which meant that for these participants the processing of their visual inputs was limited to a single hemisphere. There were six patients with either hemianopia or quadratic anopia. The former condition involves the inability to process visual information from half of the visual field – the left visual field if they have suffered brain damage to the right cerebral hemisphere, or the right visual field if the damage is in the left hemisphere. The latter problem is a similar loss of visual ability, but awareness is limited to either the top or bottom half of the affected visual field. There were four patients with damage to their left hemisphere, and two with damage to the right. In addition, the experiment included 26 intact-brain participants.

THE TEST

The participants undertook two blocks of 26 trials, one block involving estimating the length of, and the other block involving grasping, one of five black wooden bars. Two of the bars were 6cm long and were positioned as the lines of a Müller-Lyer illusion (see figure 3.8 below), the other three bars were 4, 6 and 8cm long and were positioned on a white background. The gap between thumb and forefinger was recorded for each trial, and compared with the size of the relevant bar. The accuracy of the grip used on the bars with a non-illusory back-ground was used to adjust the data obtained in respect of the two bars in the illusion.

Figure3.8 The Müller-Lyer Illusion
(both lines are actually the same length)

Participants were required to keep their gaze on a fixation point, and the block to be either estimated or grasped was revealed by removing a covering white card. The direction of their gaze was monitored, and if it moved away from the fixation point that result was excluded from the test. If the block was located to the left of the fixation point it would be processed by the right hemisphere and the estimating/grasping action would be taken by the left hand; the opposite hemisphere and hand were involved if the block was positioned to the right of the fixation point. Control subjects had blocks randomly located on both sides of the fixation point, whereas for the brain-damaged patients the blocks were always positioned to be viewed by the undamaged hemisphere.

THE RESULTS

There were significant differences in the results for the three categories of participants: the brain-intact, the left hemisphere damaged, and the right hemisphere damaged. The results for each visual field are summarized in the table 3.2 overleaf.

Task	*Control*	*Right Hs Damaged*	*Left Hs Damaged*
Estimating - RVF	1.1	1.7	
Grasping - RVF	0.75	0.1	
Estimating - LVF	1.0		1.6
Grasping - LVF	0.6		1.7

Table 3.2 Error (cm) in estimating and grasping due to Müller-Lyer Illusion[1]

THE CONCLUSIONS

The first point to note is that the patients using only their left hemisphere were affected by the illusion when asked to estimate the size of the target object – using the ventral pathway – but were not affected by the illusion when grasping – that is, utilising the data from the dorsal pathway. This supports the conclusion based on DF's behaviour that we have C-conscious access only to the ventral pathway, and that decisions reached C-consciously about objects on the basis of the data from that pathway are communicated to the ACM. This module then draws on the data from the dorsal pathway for tactical planning and control of the necessary actions directed at those objects.

In complete contrast, those patients utilizing only their right hemisphere made the same error on grasping as they did on estimating. From this we can conclude that there is not a module in the right hemisphere controlling action in respect of objects corresponding to the Action Control Module in the left hemisphere. Furthermore, if the data provided by the dorsal pathway is specialized for visuomotor control, and provides accurate information about size and orientation, then that data was not used to control grasping in this situation.

I suggested earlier that the evidence from primates is that they have conscious access to both dorsal and ventral pathway outputs, and that this would imply that in humans B-consciousness would also have access to both pathways. It may be that when there is a discrepancy between the two sources of information, we B-consciously select the output of the ventral system – since this is the output normally used for reasoning. There are processes in the right hemisphere that control action by the left hand – what I referred to earlier as the Action Control System or ACS – and in brain intact individuals the evidence indicates that this system responds to commands from the Action Control Module in the left hemisphere. In this case such commands were not available, and so information to control grasping had to be provided from B-consciousness – using the data from the ventral pathway. This would explain why for these patients grasping was as prone to illusion as estimating.

The brain-intact participants were affected by the illusion in both estimating and grasping tasks, although to a significantly greater extent in the former case. There was little difference whether the object was presented in the left visual field or the right visual field. This is as would be expected, since although visual inputs are processed within the contra-lateral hemisphere to the visual field, the results of that processing are

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[1] Because the experimenters used a purpose-designed system for measuring maximum grip aperture, and not the standard Optotrak device, the errors recorded are significantly higher than those found in other similar experiments (Bruno & Franz 2009, p 1429). This does not negate the value of the results in terms of the differences between different tasks and different categories of participant.

shared by both hemispheres. The significant question to answer is why – given the role of the ACM – these participants showed an error in grasping, unlike the patients using only the left hemisphere.

One explanation that has been proposed is that different illusions may arise at different stages in visual processing, and that illusions that arise in the earlier stages might therefore affect both visual pathways (Milner & Dyde 2003). This possibility is borne out by differences in the affect of two different illusions, as will be discussed below. It fails, to explain, however, why the illusion has a greater affect on the ventral pathway than on the dorsal pathway, and there is, perhaps, another possibility in this particular case that should not be overlooked.

Since the patients using only their right hemisphere were as bad at grasping as they were at estimating, we can infer that even when the target was presented to the left visual field of brain-intact participants, and visual processing took place in the right hemisphere, the grasping action was controlled by the ACM. However, we can also infer that the control exerted by the ACM was dissipated to some extent by some other factor. Although it is clear that the participants in the experiment had some visual awareness of the movement of their hand and arm whilst grasping, we cannot account for the effect on grasping by C-conscious interference with the movements initiated by the ACM, since if this were the case the same effect should have been seen in the patients using only their left hemisphere. It is possible, however, that in brain-intact patients actions initiated by the ACM were affected by B-conscious awareness of the illusion and resulting interference.

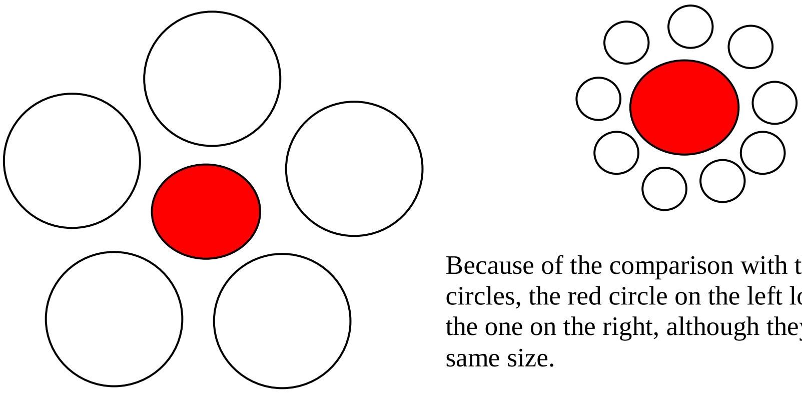
There were several cases reported in chapter 2 where actions were initiated B-consciously, with the individuals concerned being C-consciously unaware of the reasoning behind those actions. I have already made the case that we B-consciously choose the data from the ventral pathway when it conflicts with data from the dorsal pathway. This raises the possibility that the participants tried B-consciously to correct the actions that had been initiated C-consciously, since the visual feedback showed that the grasping motion did not conform to the ventral pathway data.

SUMMARY: In one experiment based on the Müller-Lyer illusion, all participants were affected by the illusion when estimating the size of the target object. However, when it came to grasping the object, those participants using their left hemisphere were unaffected by the illusion, whereas those using their right hemisphere were affected equally whether grasping or estimating. Brain intact participants were less affected in grasping than in estimating: the extent to which their grasping was affected may be due to B-conscious attempts to adjust the grip originated C-consciously.

I will review another paper dealing with the Müller-Lyer illusion in section 3.3.3, but before that I turn to another experiment based on illusion: in this case two different illusions.

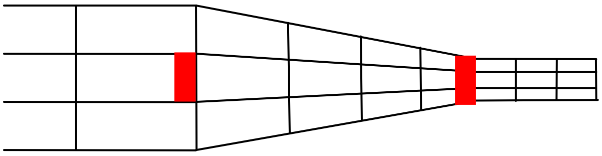
3.3.2 The Ebbinghaus and Ponzo Illusions

The second experiment based on illusion that I will review (Gonzalez et al 2006) made use of the Ebbinghaus[2] and Ponzo illusions illustrated in figures 3.9 and 3.10 below).



Because of the comparison with the surrounding circles, the red circle on the left looks smaller than the one on the right, although they are both the same size.

Figure 3.9: The Ebbinghaus Illusion



Because the black lines create a sense of perspective, the two red bars appear to be different sizes, although in fact the same

Figure 3.10: The Ponzo Illusion

THE TEST

In the main experiment, 20 participants (11 right-handed and 9 left-handed) were tested with the Ponzo illusion, and 26 (evenly divided between right- and left-handers) were tested with the Ebbinghaus illusion. The illusions were constructed on a black table top with either a 40mm long bar (Ponzo) or a 25mm diameter disc (Ebbinghaus). Two other layouts were constructed as controls, with two different size targets and a non-illusory background. The Ponzo illusion was paired with a control in which the lines were only horizontal and vertical with no perspective, and with two bars, one 40mm and one 50mm. The Ebbinghaus illusion was paired with a control in which one 25mm disc and one 31mm disc were each surrounded by an annulus of 22mm discs. In a second experiment, those recruited for the Ebbinghaus illusion trial were observed either completing a jigsaw or assembling a Lego® model, and their use of either hand to pick up pieces was recorded.

In the main experiment, grip was recorded using an Optotrak device to measure distance between thumb and forefinger, which was then compared with the actual size of the item being grasped. The participants were fitted with special goggles that became

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[2] Also known as the Titchener Circles illusion.

opaque one second after they were given the command of either “big” or “small”, to indicate which of the target objects was to be grasped. Both groups had a trial block of 24 tests, followed by an experimental block of 24 tests. Each block comprised 16 tests using the illusory background, and 8 using the non-illusory background.

THE RESULTS

The results of the main experiment are summarized in the following table:

Illusion	*Right Handed participants using*		*Left Handed participants using*	
	Right Hand	*Left Hand*	*Right Hand*	*Left Hand*
Ponzo	0.7	1.6	1.4	3.6
Ebbinghaus	0.5	2.0	0.8	1.8

Table 3.3 Error (cm) in grasping due to illusion by hand and handedness

The broad picture is that all participants were affected by the illusion to some extent, even though the task to be performed was designed to draw on the dorsal pathway. This result may at first glance seem to be in line with the results from the Müller-Lyer illusion, indicating either that the illusions arise sufficiently early in the visual processing chain to affect both pathways, or that grasping is affected by B-conscious awareness of the illusion fighting the accurate dorsal pathway data available to the ACM. However, in this experiment the participants wore glasses that became opaque one second after the order to grasp, and the effect of this on their grasping movements must be taken into account.

CONCLUSIONS

Since the output of the dorsal visual pathway does not reach C-consciousness (see section 3.1.4 and figure 3.3), it is questionable whether it can be committed to memory, but it is certain that it cannot be C-consciously retrieved from memory. There is clear empirical evidence (see Clark 2001, p 500 for a summary) that we can respond to sudden positional changes in a target when pointing, even though not aware of them, but fail to adjust for them when asked afterwards (ie, using memory) to indicate the position. As Clark puts it: “Memory-driven responses thus seem to be tied to the contents of conscious visual experience, while online object-engaging performance is driven by a distinct and more sensitive resource” (ibid).

If the dorsal pathway is only active during vision, then as soon as vision is disabled the ACM would have to rely on the memory of the target formed by the ventral pathway, which is affected by illusion. This would mean that in this experiment although grasping was initiated using data from the dorsal pathway, it was completed after vision was disabled using the stored data from the ventral pathway. In the next section I will discuss an experiment that supports this explanation for these results.

Before that, I must consider two other implications of these results. It will be seen from the table that overall right-handers showed significantly less affect of the illusion, regardless of which hand was used, and that the left hand, regardless of handedness, was more affected than the right hand. In the second experiment, where participants built a jigsaw or a Lego® model, it was noted that they favoured their right hand in picking up pieces, regardless of whether they were right or left handed. It is these factors that led to the postulation of an Action Control Module (ACM) in the left hemisphere, as discussed above. The implication would be that in right-handers the use of this specialised module is more dominant than it is in left-handers.

There were other significant differences that deserve further investigation, although the issues are outside the scope of this thesis. Left-handers were affected by the Ponzo illusion to a far greater extent than they were by the Ebbinghaus illusion. Right-handers using their left hand were more affected by the Ebbinghaus illusion, but using their right hand were more affected by the Ponzo illusion. In the case of the Ebbinghaus illusion left-handers using their left hand were slightly less affected by the illusion than right-handers using their left hand, but left-handers using their right hand were more affected than right-handers using their right hand.

> *SUMMARY:* In another experiment based on two illusions, both left-handed and right-handed participants were affected, whether using their right or their left hand. There were marked differences between all four groups and between both illusions. Since vision was disabled one second after the command to begin, it is possible that part of the reason why participants were affected by illusion is that control of grasping passed from the dorsal pathway data to the ventral pathway data from that point.

I turn now to three recent papers that challenge the claim that grasping uses data from the ventral pathway after vision has been disabled. I begin with a paper that analyses 18 previously published studies on the effect of the Müller-Lyer illusion.

3.3.3 When is grasping affected by the Müller-Lyer illusion?

This is the question that Bruno & Franz (2009) set out to answer by re-analysing the results of 18 studies based on estimating the size of, or grasping, the bars within a Müller-Lyer illusion. They carried out a detailed analysis in which they took care to adjust the published results to obtain a standard measure of difference between the maximum grip aperture (MGA) when estimating the size of an object and when grasping the object. They identified three factors that were largely responsible for differences in the effect of the illusion:

1. whether and when vision was disabled;
2. the angle of the lines forming the arrow heads, and
3. the number of trials by each participant.

Focussing on the first of these, vision can be disabled at various stages within the grasping process. The four most commonly used arrangements during experiments are:

- *Closed Loop*, when there is vision throughout the whole process;
- *Open Loop Move*, when vision is prevented once the grasping movement has started;

- *Open Loop Signal*, when vision is prevented when the signal to grasp is given; and
- *Open Loop Delay*, when vision is prevented for a number of seconds before the signal to grasp is given.

THE RESULTS

The results from each of these grasping tests can be compared with the results of perceptual tasks (such as estimating size using forefinger and thumb). Because the results of *Open Loop Delay* and *Open Loop Signal* were very similar, Bruno & Franz combine these in the results that they report, as shown in the following table:

Type of test/conditions for test	*Mean error (mm)*
Grasping – Closed Loop	4.4
Grasping – Open Loop Move	9.4
Grasping – Open Loop Signal/Delay	12.6
Perceptual	10.7

Table 3.4 Mean Error due to Müller-Lyer illusion over multiple tests

CONCLUSIONS

They conclude that in the closed loop situation, there is a “clear evidence for a difference between the perceptual measures and the action measures” (ibid, p 1431). They also found “a substantial similarity between the perceptual measures and the action measures when the action was delayed” (ibid). Both of these findings are consistent with grasping in the closed loop condition being under the control of the dorsal pathway, and grasping in the open loop condition being based on the ventral pathway when vision is removed before action starts. The mean error in the former case was 4.4mm, and in the latter case 12.6mm. When vision was disabled after movement had started, the mean error was 9.4mm, and it is surely no coincidence that the latter measure falls near the halfway point between the two extremes.

Although Bruno & Franz point out that their results, relating to grasping, differ from those of another study of the Müller-Lyer illusion using pointing, this fact in and of itself does not provide good grounds for ignoring the conclusions in the previous paragraph, especially since there are questions about when a pointing task makes use of the ventral, rather than the dorsal, pathway (see section 3.2.3 above).

Their overall conclusion is that “the perceptual and motor effects of the illusion differ only because of online feedback-driven corrections, and do not appear to support independent spatial representations for vision-for-action and vision-for-perception” (ibid, p 1421). It is not entirely clear what they mean by this claim, but I take it that they are saying that visual feedback during the process of grasping allows participants to adjust their grip, but such feedback is not available when simply indicating the size of the target without grasping it.

But if, as they claim, there are not two independent spatial representations, how do they account for the error in the first place? Why should a visual system that gets it wrong initially then be able to correct that error? Or is their claim that it is proprioceptive feedback during grasping that is responsible for corrections?

The clear evidence is that when both actions take place in closed loop conditions (with no loss of vision), the error in grasping is significantly less than the error in perception, and the authors fail to explain how this is possible if there is one common spatial representation. The difference is easily explained if grasping draws, at least primarily, on the dorsal pathway, and perception on the ventral pathway.

The variation in error on the grasping task when vision is disabled at different points in the process is consistent with the view that spatial data is taken from the dorsal pathway so long as vision is enabled, and reverts to stored data from the ventral pathway as soon as vision is disabled. I will return to this point in the following section.

One final point is appropriate. The fact that there is a small error whilst grasping in the closed loop condition may be indicative of the possibility expressed earlier that during grasping the C-consciously initiated grasp, drawing on dorsal pathway data, is affected by B-conscious feedback drawn from the ventral pathway. I will return to this point at the end of the chapter, but now I turn to two recent papers that propose a different explanation for the effect of disabling vision during grasping.

SUMMARY: An analysis of 18 experiments using the Müller-Lyer illusion shows that, when vision is disabled before the command to grasp is given, the error in grasping is similar to the error on a perceptual task. The error is less significant if vision is disabled later in the grasping process, and is consistent with a change from dorsal to ventral pathway data. Claims that this analysis shows a single spatial representation of the target do not stand up to scrutiny.

3.3.4 Does the dorsal pathway cease, or merely fade, when vision ceases?

So far in this chapter I have based my conclusions on the understanding that the data from the dorsal pathway ceases to be available as soon as vision ceases, and data must be drawn from the ventral pathway (Milner & Goodale 2006, p 247). This may be related to the fact that dorsal pathway does not reach C-consciousness. Two recent papers have challenged this view, and claim that the data from the dorsal pathway fades away over a brief period, and this fading of data accounts for the increase in error that is seen in grasping tests in illusory settings.

THE TEST

Hesse & Franz (2009) used the same stages for disabling vision as explained in the previous section: Closed Loop, Open Loop Move, Open Loop Signal and Open Loop Delay. Participants in the experiment had to pick up either bars or discs of three different sizes, and measurements were made of their Maximum Grip Aperture (MGA), the time from start of movement to MGA, and total movement time (MT). As would be expected, the earlier that vision was disabled, the greater the MGA and the longer the MT. Before I discuss their conclusions, I must draw attention to some false assumptions that they make.

ASSUMPTIONS

The first assumption they make is that the dorsal pathway remains active "even after a delay of 9 seconds between target presentation and movement initiation" (ibid, p 1537). They base this conclusion on the paper by Connolly et al (2003), which I discussed in section 3.2.2 above, where I stressed the difference between areas that are *part of* the dorsal pathway, and areas that are *served by* the dorsal pathway. The area examined by Connolly and his colleagues is involved in planning and controlling movement; although this area may draw on the dorsal pathway in many situations, activity in the area cannot be taken as proof that the dorsal pathway itself is active.

The second assumption that they make is that the timing of disabling vision controls whether data from the ventral pathway is used in grasping, and that if vision is disabled in the Open Loop Move condition – when planning of the movement has been completed – then control remains with the dorsal pathway. This assumption is supported by Milner & Goodale's original claim in 1995 (reprinted in their 2006, p 246) that the dorsal system dealing "only with objects that are visible *when the action is being programmed*" (emphasis added). However this assumption is open to challenge, and will be challenged using the results of this study.

The third assumption is that since a smooth curve can be plotted between the four different trial conditions (Closed Loop and three versions of Open Loop) then they all draw on the same pathway for their spatial data. This may by a reasonable assumption, but it falls far short of proving that the same pathway is used in all four situations.

CONCLUSIONS

They conclude that "grasping after a delay is guided by classic memory mechanisms and that this is reflected in increasing maximum grip aperture in grasping" (Hesse & Franz 2009, p 1532). The first part of this conclusion – the use of classic memory mechanisms – is based on the first assumption which is at best highly suspect, if not completely unfounded. The second part – regarding increasing MGA – can equally well be explained by a change from dorsal to ventral pathway, as I will explain by reference to another study.

The study conducted by Franz, Hesse & Kollath (2009) is broadly similar to that reported by Hesse & Franz. The main differences are (a) that they used an illusory background for their tests, and (b) that they included two additional points at which vision was disabled. These additional points were when the hand was (i) two thirds of the way from starting point to the position of the object, and (ii) one third of the way. This provides six reference points for comparison rather than just the four.

THE TEST

There were three separate experiments, based on the Müller-Lyer illusion, with the target bar having either inward pointing or outward pointing arrow heads. In each experiment there were two tasks: grasping the bar, or indicating the width of the bar (either by selecting a bar from a range of options, or by adjusting the length of a single adjustable bar). Participants wore special goggles that could be made opaque by the experimenter.

- In the first experiment, participants saw the bar for one second; then either the signal to act either came immediately and vision was uninterrupted (Closed Loop), or vision was immediately prevented and the signal to act came after a five second delay (Open Loop Delay).

- In the second experiment the Closed Loop option was replaced by an Open Loop Move option, where vision was disabled as soon as the participants began to move their hand.

- In the third experiment further options were added, with vision being disabled one-third of the way from starting point to grasp (Open Loop Move 1/3) and two-thirds of the way (Open Loop Move 2/3), and the Closed Loop option was restored.

THE RESULTS

The table 3.5 below summarises the illusory affect on perception and grasping over all three experiments. This affect was calculated as the difference in MGA when responding to the two different Müller-Lyer bars. It will be noted that the error increases steadily as the length of time before vision is disabled is decreased, and this led to the conclusion that the increase "is not due to memory demands but to the availability of visual feedback during movement execution" (ibid, p 1518).

Type of test/conditions for test	*Mean error (mm - rounded)*
Perceptual – Closed Loop	4.0
Grasping – Closed Loop	0.5
Grasping – Open Loop Move 2/3	1.0
Grasping – Open Loop Move 1/3	1.5
Grasping – Open Loop Move	2.0
Grasping – Open Loop Signal	2.5
Grasping – Open Loop Delay	3.5
Perceptual – Open Loop Delay	4.0

Table 3.5 Mean Error due to Müller-Lyer illusion over three experiments

CONCLUSIONS

The authors claim that these results show that "there is no evidence of a shift from dorsal to ventral control", and that so long as vision is enabled there are online corrections to the grasping movement. The fact of online corrections demonstrates, in their view, that a single representation of object size in involved, and that there is no evidence of a shift from dorsal to ventral control.

As in the previous case, their claim is that a single system begins to grasp with an inaccurate estimation of the size of the object, and steadily corrects that estimate so long as vision is enabled. As pointed out earlier, this raises the question of why the system got it wrong in the first place and needs to make corrections.

However, the results are also consistent with the view that MGA is controlled by accurate data from the dorsal pathway whilst vision is enabled, but is then adjusted towards the illusory size of the object to be grasped calculated from data in the ventral pathway. The longer that the latter data is used, the more closely the result matches the illusory size revealed by perceptual tasks. On this interpretation of the results the move from dorsal control to ventral control is clearly demonstrated.

I take it therefore that the authors of these two papers have failed to make their case that the standard two pathway view is wrong, and that the data that they report can, in fact, be taken to support that view. There is thus no reason to abandon the conclusions that I have drawn from the illusion experiments, and in the final part of this chapter I will draw those conclusions together into a coherent picture.

SUMMARY: Claims that experimental data disprove the existence of two separate visual representations that are used to control actions in respect of a target object are open to serious challenges. In particular they fail to explain why a single representation is responsible for both an initial error and the process of correcting that error.

3.4 Vision and consciousness: the general picture

In this final part of the chapter, I summarise the picture that has been revealed about the relationship between vision and consciousness in each hemisphere.

- There are two cortical visual pathways in each hemisphere: the ventral and the dorsal. (3.1.1)

- The ventral pathway is specialised for perception: it enables us to be aware of what is within our visual field, to identify and classify the objects in that field, and to reason about those objects. The information is coded allocentrically and can be committed to memory and retrieved as necessary. There is no need to recompute the information about objects simply because we move: their identification and relationship with other objects remains constant. (3.1.1; 3.2.1)

- The dorsal pathway is specialised for the control of bodily actions in respect of objects within our visual field. The information about objects is coded egocentrically and is recomputed every time we move; it is not remembered and is not available when vision is disabled. (3.1.1; 3.2.2)

- There are a number of circumstances in which movements in respect of objects are controlled by data from the ventral system, even when the dorsal pathway is active. These are (1) quasi-linguistic actions about an object; (2) movements directed to locations where it is consciously calculated that an object will, or would, be; and (3) movements that involve novel actions for which no schema exists. (3.2.2)

- The ventral pathway in the left hemisphere serves C-consciousness, and in the right hemisphere serves B-consciousness. (3.1.4)

- The dorsal pathway in the left hemisphere does not serve C-consciousness, but serves the specialised Action Command Module (ACM) that is responsible for tactical planning of movements. (3.1.4)

- Decisions to act are taken C-consciously using data from the ventral pathway and the information passed to the ACM where it can be matched to the data available from the dorsal pathway. (3.1.4; 3.2.2)

- The dorsal pathway in the right hemisphere serves both B-consciousness and the Action Control System. (3.1.4)

- When the information in the two pathways is inconsistent – as in the case of illusory settings – B-consciousness makes use of the data from the ventral pathway. (3.1.4)

- When there is no restriction of vision, it is possible that a grasping movement initiated C-consciously and drawing on the dorsal pathway may be affected by B-conscious attempts to correct the grasp based on data from the ventral pathway. (3.3.3)

- If vision is disabled before a movement is begun, that movement draws on the remembered data from the ventral pathway. (3.1.1; 3.3)

- If vision is disabled during movement, data from the dorsal pathway ceases to be available and is replaced by remembered data from the ventral pathway. (3.3.3; 3.3.4)

Much of the data in this chapter has been drawn from neurological and psychological studies, and very little has been drawn from the philosophical literature. The reason for this lack is that philosophy has, by and large, failed to deal with the existence of two distinct visual pathways. One notable exception is Clark (for example, his 2001, 2007 & 2009). Nevertheless, the issues identified in this chapter, for example a possible conflict between C-conscious and B-conscious control of grasping, have important implications for the philosophy of mind.

In the next chapter I will consider the implications for philosophical views about vision and visual perception of (i) two centres of consciousness – located in different hemispheres and with differing characteristics – and (ii) two visual pathways with differing roles.

CHAPTER 4

CONSCIOUSNESS, VISION AND PERCEPTION

In the previous two chapters I have outlined the evidence for two essential dichotomies in the human mind, one involving creature consciousness and the other involving vision. I have shown that each hemisphere of the brain supports consciousness, and that these two centres of consciousness are distinct forms of consciousness. The right hemisphere has a basic form of consciousness, which I have termed B-consciousness, that is inherited from and shared with animals, and is capable of simple reasoning and the initiation of behaviour, but lacks language. The left hemisphere has a more complex form of consciousness, which I have termed C-consciousness, that has developed in humans alongside the development of language, and is capable of complex reasoning, introspection, and the linguistic reporting of mental states and their contents.

The human visual system is complex with both subcortical and cortical visual pathways, with the latter accounting for more than 90% of the axons forming the optic nerve (Gazaniga et al 2002, p 153). I have outlined the evidence for two distinct cortical visual pathways – the ventral and the dorsal – in each cerebral hemisphere. The ventral pathway is specialised for the identification and classification of objects and properties of objects in the visual field, whereas the dorsal pathway is specialised for the control of actions directed at those objects.

C-consciousness is served by the ventral pathway in the left hemisphere, but the dorsal pathway serves the Action Command Module in that hemisphere and does not reach C-consciousness. The evidence suggests that in the right hemisphere both pathways serve B-consciousness, but when the information provided by both pathways is inconsistent it seems that preference is given to the ventral pathway.

C-conscious decisions to act in respect of objects in the visual field are made on the basis of information from the ventral pathway and are passed to the Action Command Module. This module connects the spatial data available from the ventral pathway with that available from the dorsal pathway and, with certain exceptions, utilises the latter data to plan the necessary movements and pass commands to the Action Control System(s) in the relevant hemisphere(s) (for the exceptions see section 3.2.4). Data from the dorsal pathway becomes unavailable if vision is disabled at any stage in this process, and from that point on both the planning and the control of movement draw on stored data from the ventral pathway. The diagram overleaf provides a simplified plan of vision and action in humans.

Existing theories about perception, and the existing vocabulary used to describe visual perception, fail to take account of the complexities revealed by this diagram. A theory of human visual perception must incorporate the presence of two visual pathways and the processing of visual input by two different forms of consciousness.

A complete theory of visual perception is beyond the scope of this thesis, but in this chapter I address two sets of questions whose answers must form part of such a theory.

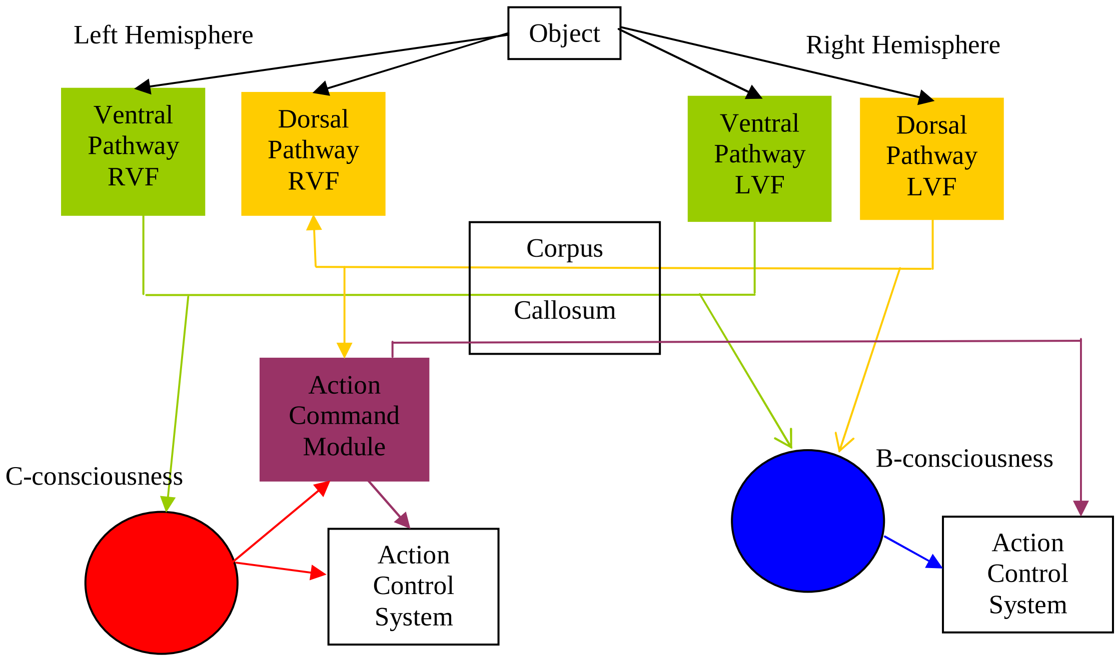

Figure 4.1 The human visual system, consciousness and action

- To what visual processes should the term "see" relate? Is seeing limited to the ventral pathway? Do we see both C-consciously and B-consciously, or only the former?

- If we limit "seeing" to the ventral pathway, what about perception? Given the significant differences in cognitive processing in the two hemispheres, is it appropriate to talk about "perception" in both cases?

I begin with the problem of defining the terms 'sight' and 'seeing'.

4.1 The problem of sight

In this part of the chapter I address the issue of how we are to understand and use terms related to the most significant of the five senses: sight. Some of the questions to be addressed are:

- Is the phenomenon of sight limited to visual processing in the ventral pathway, or can we be said to see what is processed through the dorsal pathway?

- If an object is shown in the left visual field of a split-brain patient, and the visual input is processed in the right hemisphere, do they "see" that object? Is the visual process in this case the same as that when an object if shown in the right visual field of a split-brain patient and is processed in the left hemisphere?

- Does the person driving on automatic pilot “see” the red traffic light that causes them to halt? Does the sleep-walker “see” the letter which they pick up to take to the post?

- If we apply the term “see” to visual processing via the ventral pathway in both hemispheres, do we need separate terms to mark the distinction between C-conscious seeing that we can introspect and report verbally, and B-conscious seeing of which we are C-consciously unaware?

I begin with visual processing in the different visual pathways, and the phenomenon that has been termed ‘blindsight’.

4.1.1 Visual processing in the dorsal pathway

In the 1980’s the case of DB reported by Weiskrantz (1986, 1987) raised new questions about visual processing in the human brain. DB had an operation to remove an angioma from part of the ***occipital lobe*** in his right hemisphere, and the area involved formed part of the Primary Visual Cortex, or area V1. As a result, DB had a ***scotoma*** – an area within his left visual field where no visual information reached consciousness, and where he was therefore blind.

A scotoma is distinct from the blind spot which we all have in each eye. The blind spot is formed by the area where the optic nerve leaves the back of the eye, so that there are no rods and cones to respond to light. We are not generally aware of our blind spot, since the visual system normally compensates for it, but it can be revealed in experiments.

In DB’s case his blind spots were identified experimentally, and he then underwent a series of tests on each of his blind spots and on several locations within the scotoma (Weiskrantz 1987, pp 81ff). Each site was targeted in a series of pseudo-random tests and DB was given the forced choice of whether or not a light had been detected at that point. (He was not told the results until the whole series of tests was finished.)

When the target area was either of his blind spots, his responses were at chance level (43% correct). But when the target areas were within the scotoma, his forced choices, or guesses as he thought of them, were more than 90% accurate. Despite the damage to one specific area of visual processing it was clear that some visual information was influencing his “guesses”. In most cases DB reported no awareness of any sort during the tests, but for one specific location he reported that he felt “something coming in” (ibid, p 82).

Based on the information about the two visual pathways in the previous chapter, we can surmise that the damage caused by the operation was to the ventral visual pathway. This would account for his inability to report experiencing anything during the tests (the one exception may point to one area where some residual processing was still possible). If the dorsal pathway was spared, then visual information via that pathway would reach B-consciousness.

In chapter 2 (sections 2.3.4 and 2.3.5) I described experiments in which it appears that participants made B-conscious decisions to act in situations where C-consciousness lacked data on which to make a decision. In chapter 3 I pointed out the possibility, based on animal studies and human behaviour, that B-consciousness is served by both visual pathways. If DB's dorsal pathways were intact, and data from the experiment reached B-consciousness, then DB could B-consciously decide whether or not he had seen a light. It is possible that the Interpreter Module (see sections 2.1.6 and 2.3.4) was able to access the result of the B-conscious decision, although not, of course, the reasoning behind it.

In this situation DB would have no C-conscious visual input from the area of the scotoma, but would be C-conscious of the output from the Interpreter Module (see part 4.2 below for further details). This would explain how DB could accurately report what had occurred but understand his choices as guesses. Weiskrantz adopted the term "blindsight" to describe this phenomenon of responding to visual input without [C-]conscious awareness of the input.

SUMMARY: A case study of a patient with a scotoma, revealed the ability to accurately "guess" the presence of a stimulus in the absence of consciousness of the stimulus. I have proposed that this phenomenon, termed 'blindsight', can be explained by B-conscious awareness of visual input via the dorsal pathway, and that B-conscious decisions about visual input are detected by the Interpreter Module and interpreted as guesses.

This raises the question of whether 'sight' should be applied only to C-conscious visual input, or also to B-conscious vision. Before I address that question, I return to a case (discussed in 2.3.1) where blindsight may provide the explanation for observed behaviour.

4.1.2 A case of unconscious driving

In chapter 2 (section 2.3.1) I reported the case of a driver who continued his drive home whilst in the throes of a *petit mal* seizure, and a pedestrian in the same situation who continued to walk home whilst threading his way through the crowds. The cases have been discussed by Searle (1992, pp 108-109) and Block (1997, p 397), although they reach opposite conclusions. Searle describes the driver as totally unconscious, whereas Block regards him as phenomenally conscious but lacking access consciousness.

I drew a distinction between this driver, and a person driving "on automatic pilot". I claimed that in the latter case the driver was responding to visual inputs B-consciously (whilst C-consciously engaged with his inner thoughts), but rejected this explanation for the *petit mal* sufferer. We are told that he went through at least one set of red lights (Penfield 1975, p 39), and the identification of traffic lights as signals to be obeyed requires consciousness. If this driver was not responding to his environment C-consciously – because of the seizure – and not responding B-consciously – which we deduce because he failed to understand the meaning of red traffic lights – how are we to understand his behaviour? After all, he negotiated traffic and road junctions without crashing.

In chapter 3 (3.2.2 & 3.4; see also figure 3.6) I referred to the three stages involved in action once a decision to act has been made: strategic planning, tactical planning and action control. The first of these involves consciousness and the data from the ventral visual pathway, but generally speaking (I listed the exceptions in 3.2.2) tactical planning and action control pass to the Action Command Module and Action Control System, and they draw on the dorsal visual pathway and stored schemas.

It is not possible to determine from the information available whether the driver in the throes of a *petit mal* seizure lost both C-consciousness and B-consciousness, or only the former. But even if he remained B-conscious, we can judge that he was not driving B-consciously. However, since the decision to drive home, the strategic planning of his actions, and the selection of the appropriate schema, all took place before the seizure began, there is no reason why he should not follow the well-established route home and avoid other traffic using data from the dorsal visual pathway, which would not cease to operate because of a loss of C-consciousness.

SUMMARY: The case of someone continuing to drive home whilst in the throes of a *petit mal* seizure, without crashing but without obeying red traffic lights, can be explained by blindsight. If the decision to drive home and the implementation of that decision by the Action Command Module occurred whilst still C-conscious, the Action Control System would continue to have access to visual input via the dorsal pathway; this would enable the driver to respond to familiar landmarks and other traffic, but not to respond to traffic lights.

This explanation contrasts with the case of the driver on automatic pilot where B-conscious control of driving provides the best explanation. However, this still leave us with the question of whether it is appropriate to use the term ‘sight’ for B-conscious visual inputs. Does the driver on automatic pilot “see” the red traffic lights that cause him to stop, and the green lights that prompt him to start moving again? This will be the topic for the following section.

4.1.3 B-conscious sight

If the driver were asked, once he was again driving C-consciously, why he had stopped at the traffic lights, he might well reply “I must have seen that they were red”. This is similar to the response of the soldier who, when asked why he had halted and brought his gun to bear on a rooftop, replied, “I must have seen something” (see 2.3.2).

The evidence from split-brain patients outlined in chapter 2 (part 2.1) is unequivocal: in whichever part of the visual field an object is displayed – so whichever hemisphere carries out the visual processing – the patient sees the object. By that I mean that the patient becomes aware of the presence of the object within the visual field and is able to reason about the object. Although a split-brain patient cannot use language to report the presence of and to name an object in their left visual field, with the visual input processed in the right hemisphere, this provides no reason for denying that they see the object.

The experiments reported in 2.3.4 and 2.3.5 also provide clear evidence that the participants saw what was before them B-consciously as well as C-consciously. It makes no sense to deny sight either (i) to split-brain patients using their right hemisphere, or (ii) to those with intact brains who respond B-consciously to visual input that they cannot introspect or report C-consciously. However, the use of the terms 'sight' and 'see' for visual processing via the ventral pathway serving B-consciousness as well as the pathway serving C-consciousness raises both conceptual and semantic problems.

SUMMARY: There is clear evidence that split-brain patients see with their right hemisphere, that is B-consciously. There are also times when brain-intact persons can be judged to see B-consciously.

4.1.4 Distinguishing between B- and C-conscious sight

The recognition that we see B-consciously as well as C-consciously creates a problem with our use of the term 'see'. When someone says "I see . . ." they are referring to an experience that they can introspect and report. There are, however, instances when someone would be unable to say "I see", but their behaviour provides evidence of sight. In such cases they may concede "I must have seen". "See" clearly means something different in these two situations.

SCENARIO 4.1[1]

A student has been recruited for an experiment. She sits in front of a computer screen and is told to watch for a symbol that will appear. She watches closely, but is not aware of seeing anything. After a few minutes, she reaches across and picks a bottle of water from a selection of five different varieties available. "Did you see anything?" asks the researcher. "No," replies the student. "Is that the usual bottled water that you drink?" "No. Actually I usually drink Brand B." The researcher then reveals that an image of the brand that she chose had been displayed on the screen for 300 milliseconds.

It was seen in chapter 2 that visual inputs take longer to reach consciousness in the left hemisphere than the right because of the subconscious hypothesis forming and theorising that takes place in the former. The fact that the picture of a bottle of water did not reach C-consciousness does not mean, of course, that it did not reach B-consciousness. Neither the student's decision to select a particular bottle of water, nor the subsequent action of picking it up, meet the criteria for subconscious behaviour. There is no need to assume higher order representations or complex thinking

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[1] This simplified scenario reflects experimental data. See, for example, Baldwin et al (1990).

to explain her decision (see Definition 2 in 1.5.3). The logical explanation is that she saw the picture B-consciously, and made a B-conscious decision.

This experiment underlines the fact that the term "see" is used in every day experience to denote C-conscious visual experiences. However, to limit it to this meaning is to deny the term 'sight' for B-conscious visual experiences, and thus to split-brain patients using their right hemisphere and to animals (among others). Whilst it is not practical to change the use of the term 'see' in normal language use, I suggest that in philosophy, psychology, and neuroscience it is important to distinguish between C-conscious sight and B-conscious sight.

The obvious difference between visual processing in the separate hemispheres is that we can introspect and verbally report what we C-consciously see, but we cannot introspect or report what we B-consciously see. There is, however, another significant difference. In chapter 2 I reviewed the evidence from split brain patients that shows significant differences in how the hemispheres operate. The left hemisphere lacks some of the visual discrimination capacity of the right hemisphere, but instead focuses on theorising about sensory inputs – forming and testing hypotheses – and has a capacity for complex reasoning that the right hemisphere lacks.

Although both hemispheres receive the same visual input via their ventral pathway, it seems highly unlikely that they process that input in the same way. If we retain the concept of 'perception' for visual (and other sensory) processing in the left hemisphere, then we require a different concept (and a different term) for visual (and other sensory processing) in the right hemisphere. This is the issue to be addressed in the rest of this chapter.

SUMMARY: It makes no sense to limit sight to C-conscious visual processing, since this would deny that animals see and that split-brain patients see using their right hemisphere.

CLAIM 4: Humans see both B-consciously and C-consciously.

But if we see both B-consciously and C-consciously, how do we differentiate the top-down visual processes in the two hemispheres? The answer to this question will occupy the rest of this chapter.

4.2 Perception

In traditional philosophical terms the verb "to see" is a "perceptual" verb, that is, seeing is a form of perceiving. In part 4.3 I will explain why it is inappropriate to use the term 'perception' of visual processing in the right hemisphere. But if perception is to be limited to the left hemisphere and C-consciousness, although sight is common to both C-consciousness and B-consciousness, then it is necessary to separate "seeing" from "perceiving". In this section I focus on top-down visual processing in the left hemisphere, and distinguish between visual experiences and perceptual experiences – between seeing something and perceiving it.

CLAIM 5: In humans, [C-conscious] seeing and perceiving are two distinct processes.

I will justify this claim with a number of different scenarios and the insights that they provide, starting with a well-documented neurological condition.

4.2.1 A failure of perception

SCENARIO 4.2
The patient, P, is sitting in his doctor's office where they are discussing the effects of an earlier brain operation. P appears to be an alert and sensible individual and passes various neurological and psychological tests without any problem. Then the door opens and his wife enters. "Who is that?' asks the doctor. "I don't know," replies P. "She looks exactly like my wife, but she is not my wife; she is an impostor."

The patient in this scenario is suffering from the Capgras Syndrome (Joseph 1996, p 99). If asked whether he sees his wife in the room, the sufferer would answer "No". In this case he is not denying a C-conscious visual experience, but rather a C-conscious perception. We can judge that his denial is not due to any defect in his visual system, since he claims that the person he sees is identical in appearance to his wife. His rejection of her as his wife is clearly made on non-visual grounds.

P's visual system produces, via the ventral pathway, a representation of the person before him that matches in every important respect the stored representation of his wife's visual appearance. He has a similar representation of his wife's voice, and if his wife had telephoned the doctor's office instead of coming in, the patient would have had no hesitation in accepting that it was his wife on the phone. So although his claim that it is not his wife clearly relates to visual processing, it cannot be based solely on what he sees.

SUMMARY: In the case of Capgras Syndrome, there is a clear difference between the sufferer *seeing* his wife and *perceiving* his wife.

In section 4.2.4 I will discuss the role of the Interpreter Module in integrating visual and other sources of data to create perception. The claim that I am making is that the unusual affect of Capgras Syndrome is not the result of some unique process, but the incorrect result of a process that we all experience all the time. I will discuss that process in detail shortly. Before that, I explore other evidence for the distinction that I am making.

4.2.2 Perception and conception

Perceptual states involve some form of conceptual content. One cannot perceive something for which one does not possess a concept. As Lowe puts it in his *Introduction to the philosophy of mind*, "it does seem that one must be able to bring the [seen] objects in question under concepts of some sort if one is to have . . . a perceptual experience" (Lowe 2000, p 105). A young child may have the same visual input when confronted with an object as their parent, but whereas the parent *perceives* the vacuum cleaner, the child cannot perceive it, since she lacks the concept of vacuum cleaner.

However, to describe the parent's visual experience as "perceiving a vacuum cleaner" is misleading. The visual experience may result in the perception of a vacuum cleaner, but the experience is distinct from, and much richer than, the perception. To quote Lowe once more:

> [D]o perceptual experiences typically have *non*-conceptual content in addition to conceptual content? One reason for thinking that this might be the case is that the perceived scene is often of such richness and complexity that it is hard to suppose that anyone could in fact bring all of its ingredients under concepts, even if he or she possesses the requisite concepts to do so. (Lowe 2000, p 134 – italics in original)

Carruthers make a similar distinction, although in different terms. He describes concepts as being "wholly 'chunked' or 'digital' in nature", whereas percepts in contrast "while being *imbued* with concepts (often or always), contain representations more finely grained than any concept; these representations are analog" (Carruthers 2000, p 133 – italics in original).

Although both Lowe and Carruthers view the richness of the non-conceptual content of visual experience as one aspect of perception, I am making the case that this rich non-conceptual experience is "seeing", and that perception only occurs when concepts are applied to what is seen and assumptions are made. The important point about this latter stage is that it does not depend solely on what is seen, other factors are brought to bear – as in the case of the Capgras sufferer.

SUMMARY: There is a difference between the rich detailed non-conceptual visual input that we *see*, and the more limited conceptual information that is extracted from it so that we *perceive*.

In the following section I will look much more closely at the process of perception, and the role that non-visual data play in perceiving what we see. I will do so by comparing several scenarios that involve, or appear to involve, an apple.

4.2.3 A problem with apples

In this section I compare several different scenarios in which it is to be assumed that the non-conceptual visual content is the same, but where perception and reality differ. The purpose is to demonstrate that there is a real distinction between what we see and what we perceive. I begin with a claim published on the University of Glasgow's Philosophy Department website in 2010 as part of an invitation to submit papers for a conference on perception.

SCENARIO 4.3
[I]magine looking at an apple. The colour of the front face of the apple is something that is phenomenally given to you in a typical visual experience of an apple. This is a property that the facing surface of the apple seems to have and to which we seem to have direct access in visual perception. . . Some people think that when looking at an apple it is part of the way that the apple appears that it is a whole round object even though there is clearly a sense in which we don't see the whole round object – we don't see the back side of the apple. Such people would think that the back side of the apple is phenomenally given in experience, but it isn't given in the same way that the colour of the front surface of the apple is given.
(downloaded from philosophy.arts.gla.ac.uk on 12/03/10)

The visual experience described here includes the colour of the visible area of the apple's outer surface, the shading of colour on that surface that provides evidence of depth, and the shape of the visible area. Those features can be compared with a stored representation of the visual appearance of an apple, and an assumption can then be made that it is an apple. The concept of apple contains far more than colour and shape: it includes among other things the complete three dimensional body of the apple, the texture of the apple's skin and the taste of apple.

It is the association of what is visible with the concept of apple that provides the evidence for the back side of the apple: it is not "given" in the visual experience. It would be possible for someone to have cut an apple in half and placed it in such a way that your visual experience of the facing side was identical to the visual experience when viewing a complete apple. But in this case the assumption of completeness would be unfounded. There is no visual detail that distinguishes the complete apple from the half apple.

SCENARIO 4.4
You go into a hotel, and on a table in the reception area you see a sign bearing the legend "AFMA →", and below it an apple; or rather, you see the colour, shading and shape of the visible area of the apple's surface that is facing you. These are identical to the visual appearance in the previous scenario. Being rather thirsty after your long journey, and assuming that the apple is available for guests, you pick it up and take a bite. You get a shock when you discover that the apple is made out of wax. It is only later that you discover that AFMA stands for the Artificial Fruit Manufacturers' Association.

What you perceived, based on the visual evidence before you, was an apple – a real apple with its juicy thirst-quenching properties. The assumption that you made was no more unrealistic than the assumption referred to in the previous scenario that the apple was whole. But now imagine one of the conference attendees looking at the apple, and assume that his visual experience of the colour, shading and shape of the visible surface was identical to yours. Given the different knowledge that he possessed would he have perceived a real apple – or an artificial one?

SCENARIO 4.5
You have been visiting an art exhibition in a stately home. Worn out and thirsty from your exertions, you sit down for a rest. On the wall opposite you see a semi-circular occasional table, and sitting on the table is an apple. You have the same visual awareness of colour, shading and shape of the apple's face as in the previous scenarios. You think longingly of the taste of apple. When you get up, you cross the room to take a closer look, and discover that you have been looking at a *trompe l'oeil* painting.

This experience shows that even the awareness of depth that seemed an integral part of the visual experience in the previous two scenarios is, in fact, an assumption. A clever artist can shade colour in such a way that there is an appearance of depth, even on a flat surface. The curator of the exhibition could sit in the same place as you, have the same visual input, but not perceive a real apple.

What these three scenarios demonstrate is that despite the richness of the non-conceptual visual representation formed by the ventral visual pathway, the visual information on which we base perception is very limited. The conceptual content of our perception far outstrips what it visually given. It is our knowledge – or in some cases our lack of knowledge – that combines with the visual data to produce visual perception.

SUMMARY: What we perceive visually is assumed on the basis of very limited visual data.

The remarkable thing is that on the majority of occasions the assumptions that we make based on limited visual data result in veridical perception. In the following section I look more closely at the process that brings this about.

4.2.4 Visual perception and the Interpreter Module

In chapter 2 (section 2.1.6) I describe an experiment on a split-brain patient that led to the identification of the Interpreter Module in the left hemisphere. This module seeks to make sense of sensory and other inputs by forming hypotheses. In this particular case, the module had access to the C-conscious reasoning and the resulting selection of pictures by the right hand, and to the action of selecting pictures by the left hand, but did not have access to the B-conscious reasoning behind the left hand's action. The reason advanced by the patient for his choices was therefore a fiction: an attempt to construct a logical explanation in the absence of some of the facts.

This same process was seen at work in an experiment described in section 2.3.4. The participants were asked to select one of five identical objects, but after they had made their choice they confabulated their reasons. I claimed that the confabulation arose because lacking a basis for a C-conscious choice between the objects, the participants made their choice B-consciously. But since the Interpreter Module only has access to the action of choosing, and not to the B-conscious reasoning in the right hemisphere that determined the choice, it was forced to make up reasons.

I suggest that the same process can be seen in the case of the Capgras sufferer. Faced with visual data from one source – the ventral pathway and the Face Recognition Module – but lacking data from another source – possibly the emotional response associated with seeing his wife – the Interpreter Module forms a theory. The person looks like his wife but is not his wife: therefore she is an impostor.

The evidence indicates that the Interpreter Module combines (a) the visual matching of what can be seen of an object with a stored representation; (b) other visual clues (Visual Analysis – see 4.2.6 below); and (c) other sources of information. From these a theory is constructed to provide the best match to all the available data, and this theory reaches C-consciousness alongside the purely visual (analogue) data. This arrangement is set out in Figure 4.2 below.

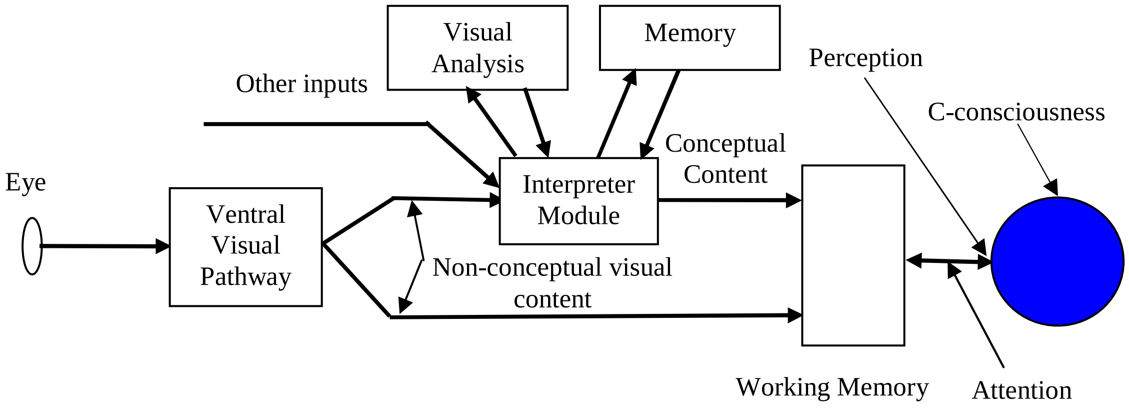

Figure 4.2: The route from visual input to C-consciousness

I have shown Attention with a double-headed arrow as I do not know whether a signal is sent to C-consciousness that data is available in Working Memory, or whether C-consciousness polls Working Memory to find out whether data is available. Which of these is the case must await empirical evidence, but the issue is not relevant to the wider picture, which is of two parallel inputs reaching C-consciousness together: the non-conceptual analogue rich detailed visual data, and the interpretation of that data – *seeing* and *perceiving*.

SUMMARY: Visual data reaches C-consciousness in two parallel forms: rich detailed non-conceptual content and perceptual content which is output by the Interpreter Module.

One of the results of this dichotomy may be seen in the phenomenon of change blindness, which is the topic of the following section.

4.2.5 Change blindness

There is now an extensive literature on change blindness, and many examples can be found on the internet (see for example http://viscog.beckman.illinois.edu). The following scenario is typical.

SCENARIO 4.6
You are watching a short film clip. In the first scene you see a young man seated at a cluttered desk. He pushes back his chair, gets up and goes to leave the room. In the second scene you see a young man leave a room and enter a corridor, where he lifts a telephone and makes a call. The chances are very high that you failed to realise that there were two different young men dressed in different clothes. (http://viscog.beckman.illinois.edu/flashmovie/23.php

The detailed rich analogue data produced by the ventral pathway of the visual system changes constantly as the scene before our eyes changes, but that data is not committed to memory. Instead, it appears that it is the output of the Interpreter Module that is memorised. As one researcher has put it:

> It appears that there is a kind of attentional "bottleneck" which limits information transfer into memory: only a fraction of the information available in a scene is transferred into visual storage for later report or comparison. . . . the code in which the information is stored in visual short term memory is not a visual code, but a code in which only the category or identity of the elements is available. (O'Regan 2010, p 5)

Which elements of the visual scene will be picked out by the Interpreter Module will vary from individual to individual and from circumstance to circumstance. But setting aside those rare individuals blessed (or cursed) with what is called "a photographic memory", it is only those elements that have reached C-consciousness via the Interpreter Module that are stored in C-conscious accessible memory.

SUMMARY: We C-consciously remember what we perceive, not what we see.

This brings me to one final example of the distinction between seeing and perceiving – the issue of illusion.

4.2.6 Visual analysis and visual illusion

In the previous chapter I reviewed a number of experiments which revealed that in cases of visual illusion the data available from the dorsal visual pathway provides generally accurate size and orientation information to control grasping, whereas actions drawing on the ventral pathway demonstrated inaccurate size and orientation information. I noted that the extent of the inaccuracy varied from illusion to illusion, and that this had led to speculation that different illusions arise at different places within the visual process (Milner & Dyde 2003). In this section I suggest an alternative explanation.

In section 4.2.4 and Figure 4.2 I made reference to a process that I termed Visual Analysis. I have treated this as a process distinct from the Interpreter Module because the process can also be found in the right hemisphere (see 4.3.5 below). What we perceive differs from what we see in several important respects. What we see is the affect of light reflected from objects onto the retina, and each object will fill a different proportion of our visual field, and form a different shape, depending upon its position. Visual Analysis is the process of adjusting our visual input to allow for the effects of distance and perspective.

Thus, for example, we perceive two lamp posts as being the same size, even though the one further from us takes up a smaller portion of our visual field. We perceive that a clock face is circular, even though the image formed in our visual field is elliptical. We perceive that a person with two legs is walking past our window, even though only their head, arms and trunk are present in our visual field.

In most circumstances the adjustments that separate perception from seeing are well founded and serve to provide us with accurate information about the world around us. Indeed, we would not last for very long if such adjustments were not made. But there are special circumstances in which the adjustments are not justified, and lead to wrong conclusions.

When we look at the Müller-Lyer illusion, the rich detailed analogue representation of what is in front of us includes two lines of equal length; but the digital representation formed by the Interpreter Module draws on the output from the Visual Analysis Module, which assumes that one line is nearer than the other, and therefore that the one that is further away must be longer. If you look at the illusion and simply compare the end points of the two lines, without using any artificial aids such as a ruler, you can see that the end points align and that they are therefore the same length.

SUMMARY: Visual illusions may arise because a specialised module that interprets raw visual input and adjusts for distance and perspective is misled and makes unjustified adjustments.

The perceptual errors that arise in the case of illusions are illustrative of a wider problem in visual perception: we perceive what we expect to perceive. This is the topic of the following section.

4.2.7 Perception and expectation

There is clear evidence that what we perceive is strongly influenced by what we expect to perceive. The literature divides perception into *bottom up* and *top down* processing. In this thesis I am making the case that as regards vision the former should be referred to as sight, and only the latter as perception. It is this stage in the visual process that is "affected by our concepts, beliefs and expectations" (Swoyer 2003, p 1).

The reason that we are misled by the Müller-Lyer illusion is that our experience of living in a community where much of our environment is "carpentered" – that is, constructed using straight edges and angles – creates expectations about how to interpret such constructions. Zulus, whose houses are circular and whose environment contains far fewer straight edged objects, are less prone to the illusion (ibid, p 5).

One influential writer on the philosophy of science has made the point in the following terms:

> [S]omething like a paradigm is prerequisite to perception itself. What a man sees depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see . . .
> In a sense that I am unable to explicate further, the proponents of competing paradigms practice their trades in different worlds . . . [and] see different things when they look from the same point in the same direction. (Kuhn 1970, pp 113 & 150)

Note that in this quotation Kuhn follows the traditional practice of using 'see' in the sense of 'perceive'. It is this traditional practice that I am claiming needs to change.

SUMMARY: What we perceive is determined in part by what we expect to perceive, and not just by the visual data.

In the following section I summarise the issues that need to be considered in developing a theory of perception that can account for the difference (a) between B-consciousness and C-consciousness, and (b) between visual processing in the ventral and the dorsal pathways.

4.2.8 Seeing and perception: a summary

In this part of the chapter I have examined various lines of argument that all point to one conclusion: that there is a clear difference between C-conscious seeing and perceiving. What we see is a rich and detailed analogue representation of the visual scene, a representation that changes as the visual scene changes. What we perceive is a very limited digital representation of what the Interpreter Module selects as relevant, and it is what we perceive that is stored in memory.

The distinction that I am making is the same as, or very similar to, the distinction that Bermúdez (2005, pp 221ff) makes between perception and cognition. He uses the term 'perception', however, for what I have termed 'sight', and 'cognition' for what I have termed 'perception'.

There are occasions when we fail to perceive what we clearly see. The Capgras sufferer fails to perceive his wife, although he sees her. In these situations the visual input clashes in some way with other sensory input, or the lack of it. We fail to perceive that the person in a video clip shown going out of a room is not the person shown coming out, although we see both persons quite clearly. This is because what we remember is the summary of the scene created by the Interpreter Module, not the rich detail from the analogue representation of the visual scene. We also perceive what we do not see; sometimes because of the deliberate act of a magician or a conman, sometimes because a brain process misinterprets what is seen in an illusion.

Perception is not determined solely by what we see. Our beliefs and expectations play a major role. We see a woman in the market, but fail to perceive our sister-in-law, because we do not expect to see her since we believe she is in America. We expect teenagers wearing hoodies to be bad, so when we see one running out of a shop we perceive a shop-lifter – not a well-behaved pupil who is late for an appointment.

> *SUMMARY:* Seeing is not perceiving: what we perceive depends not only on what we see but also on (a) other available information, (b) analysis of the visual data, and (c) our beliefs and expectations.

We need to be clear that in terms of C-consciousness, and the processing of visual data in the left hemisphere, there is an essential difference between seeing and perceiving. It is wrong to use “to see” as a perceptual verb in philosophical literature, even if it retains that sense in every day language. But what about B-consciousness and the right hemisphere, is there a similar dichotomy? The answer to that question will be found in the following part of the chapter.

4.3 Visual processing in the right hemisphere

In part 4.1, I showed that it makes no sense to deny that humans see B-consciously. But I also pointed out that there are clear differences between visual processing in the two hemispheres which need to be taken into account in a theory of human visual processing. In part 4.2, I focussed on C-conscious visual processing and the distinction between seeing C-consciously and perceiving. In this part of the chapter I discuss a similar distinction in the case of B-conscious visual processing, although with a degree of speculation, since there is less empirical evidence available. I begin with a terminological problem.

4.3.1 The terminology of B-conscious vision

In part 4.1, I argued that we should use the term ‘sight’ of both C-conscious and B-conscious bottom-up visual processing via the ventral pathway, because the similarities between the two processes outweigh the differences. To adopt a different term for B-conscious ventral pathway bottom-up processing would obscure those similarities, and would imply that ‘sight’ was a purely human phenomenon (since C-consciousness is limited to humans).

However, when we come to the later top-down stages in visual processing, the differences between the hemispheres become significant. It would be possible to talk of C-conscious perception and B-conscious perception, but this would tend to obscure the essential differences between the two hemispheres (see chapter 2, part 2.1). In part 4.2, I drew attention to the difference between C-conscious sight and perception, and stressed the role of the Interpreter Module in integrating visual input with other data sources to create visual perception. There is no equivalent module in the right hemisphere, which lacks the complex reasoning skills of the left hemisphere (see sections 2.1.7 and 2.1.8).

There is nevertheless, as will become clear through the rest of this chapter, a distinction within the visual processing of the right hemisphere that bears some similarity with the distinction between seeing and perception in the left hemisphere. Whilst it would be possible to adopt an existing term to denote the B-conscious equivalent to perception, there might well be confusion between the new specialised sense of such a term and existing well-established senses. I propose, therefore, to take the concept of “quasi perception” and form the noun ‘quaception’ and the verb ‘quaceive’ to serve as the B-conscious parallels to ‘perception’ and ‘perceive’.

SUMMARY: The terms ‘quaception’ and ‘quaceive’ are to be understood as the B-conscious equivalents to C-conscious ‘perception’ and ‘perceive’.

In the following section I explain why the concept of perception is not appropriate for B-conscious visual processing, drawing on data from split-brain patients reported in chapter 2, and on the nature of perception as discussed in part 4.2 above.

4.3.2 Why quaception is not perception

We know that a split-brain patient sees objects presented to their left visual field using their right hemisphere because of their actions using the left hand (which is controlled by the right hemisphere). One of those actions includes selecting a card with the name of the object written on it, from a selection of cards (see section 2.1.3). I have already set out the reasons why this action is not evidence of language ability in the right hemisphere (section 2.1.4), but it is also not evidence of perception.

As discussed above (4.2.2), perception involves conception: we cannot perceive something of which we lack the concept. But concept formation is part of the hypothesising and theory testing abilities that are unique to the left hemisphere. The ability of a split-brain patient using their right hemisphere to recognise the existence of a link (formed before the commissurotomy) between the stored visual image of an object and the stored visual image of a pattern of marks on a card, involves purely recognitional capabilities, and provides no proof of concept possession.

Furthermore, other tests involving the right hemisphere of split-brain patients clearly demonstrate that written words do not trigger concept recognition. Shown the two words “pan” and “water” in their left visual field, a split-brain patient is unable to select, with their left hand, a picture of a pan filled with water (section 2.1.4). Shown the two words “pin” and “finger”, the patient cannot select the term “bleed” from a list of options (ibid).

Given this clear evidence that recognition of a written word by the right hemisphere does not involve conception, we have no reason to suppose that B-consciously seeing an object involves conception. And if there is not conception, then there is no perception.

> *SUMMARY:* The right hemisphere lacks the ability to conceptualise what it sees, and in the absence of concepts it cannot be said to perceive.

I have previously shown that the right hemisphere is capable of reasoning: simply not the complex reasoning of the left hemisphere. But what plays the role in B-conscious reasoning that concepts play in C-conscious reasoning? To attempt an answer to that question I must pull together a number of threads relating to emotion.

4.3.3 The role of emotion in the right hemisphere

The right hemisphere is dominant “for emotional and social-emotional intelligence”, says Joseph (1996, p 95). The typical responses associated with emotions – including facial expressions, changes to heart rate, release of adrenaline, changes to skin conductivity – are controlled by the ***limbic system***. This system, which includes the ***amygdala*** and the ***thalamus***, formed the forebrain in reptiles, before the evolution of the neocortex in birds and mammals. It seems likely therefore that our emotional responses (or at least the more ancient ones) are inherited from our reptilian ancestors.

It is, I suggest, possible to account for reptilian behaviour in terms of their response to a very limited number of factors sensed within their environment. These factors would include food, friend or foe; and the same object could be sensed differently on different occasions. What is not sensed as food when the reptile is replete may well be sensed as food when it is starving. A male relative may be sensed as friend in one situation, but as foe when they are both competing for the same female.

At some stage during the evolution from reptile to mammal to man, sapience was added to sentience (see chapter 1, section 1.5.1). With the arrival of creature consciousness, the range of factors sensed will have grown, but I suggest that the underlying arrangement has remained the same. Within the right hemisphere, objects are not *perceived* in their own right, but are *quaceived* according to the opportunity that they afford. We can gain some idea of how B-consciousness fits into this scenario from neurological studies into fear in humans.

Sensory information reaches the thalamus via a ***subcortical*** pathway, and a signal is passed to the amygdala. This is not a sophisticated analysis of what triggered the sensation “but a crude signal . . . indicating whether this stimulus roughly resembles the conditioned stimulus” (Gazzaniga et al 2002, p 557). Although this passage refers to a “conditioned stimulus” the evidence of common emotional reactions across cultures and species (Darwin 1872/1965) suggests that the stimulus can sometimes be innate.

This subcortical triggering of the amygdala is the process that I outlined above for reptiles. But the sensory data also passes to the neocortex for a “slower . . . more thorough and complete” analysis (Gazzaniga et al 2002, p 557), which I take to be what I have termed B-conscious quaception. It is only when both routes agree that in humans the amygdala initiates the appropriate emotional response.

The role played in this scenario by the amygdala corresponds to the concept of “affect program” proposed by Griffiths (1990). He describes the concept as follows:

> An affect-program is a neural circuit, probably in the hypothalamus and associated regions [the limbic system]. When triggered, it initiates the complex series of reactions which make up an emotional response. These are generally thought to include facial expression, vocalisation and expressive vocal changes, skeletal muscular reactions, such as orienting or flinching, and changes in autonomic nervous system activity, leading to alterations in heart rate, skin temperature, and so on. (Griffiths 1990, p 180)

It also fits in with the outline of emotion proposed by Price (2005, p 14). She lists eight stages, of which the first four are:

1. An eliciting event or situation [I use the term “trigger”]

2. The “perception” of the trigger [this combines sight and quaception].

3. The processing of the “perception” [this is Griffiths’ affect program].

4. Bodily changes, both internal and external.

As well as the bodily changes initiated by the limbic system, there can be other actions initiated B-consciously. One example of this was described in Scenario 2.2 in section 2.3.2. A soldier on patrol becomes B-consciously aware of a potential danger (that is, he quaceives a potential danger) and brings his gun to bear. This is clearly a very different response from the increased heart rate and adrenaline rush that he may also have experienced.

SUMMARY: Quaception is the process of placing what is seen B-consciously within a limited range of categories, and (a) leads to emotional reactions initiated in the amygdala and (b) may result in B-conscious actions.

CLAIM 6: Top-down visual processing in the right hemisphere is linked to emotion.

I will return to the topic of the emotions and the latter four stages in Price's analysis in the final chapter of the thesis. At this point I return to the issue of visual processing in the right hemisphere.

4.3.4 The role of quaception

In the previous section I have suggested that quaception developed out of the more ancient process by which animals such as reptiles responded to their environment before the development of creature consciousness. In this section I consider what we can deduce of the role of quaception in modern man.

The first point to note is that quaception is a later stage in visual processing than seeing. In this sense it parallels perception in the left hemisphere, but there are marked differences. Split-brain patients are far better with the right hemisphere at recognising whether an object is one that they have seen previously (see 2.1.6), and this was put down to the way in which the left hemisphere theorises about the objects presented to it. But it can also be taken to show that the right hemisphere does not conceptualise what it sees.

Furthermore, the right hemisphere lacks language and does not therefore create the link between object or property seen and a linguistic label, although it can recognise such a link that has been previously formed (see 4.3.2 above). This implies that B-conscious thinking must manipulate visual images – since the right hemisphere lacks semantic images or concepts by which to individuate images. This means that the right hemisphere must commit visual images to memory, unlike the left hemisphere (see 4.2.5). This may account for the widely held view that visual art is a predominantly right hemisphere phenomenon, and that artists have a better visual memory than non-artists.

Since it is at least possible that the output of both the ventral and the dorsal visual pathways reach B-consciousness, the question arises as to which of these is committed to memory. In sections 3.3.1 and 4.3.5 I argue that if we do have B-conscious access to the dorsal pathway, we nevertheless choose to use the output of the ventral pathway when there is a discrepancy because of illusion. This suggests that it is the output of the ventral pathway that is stored as a visual image in the right hemisphere.

SUMMARY: Since quaception does not involve conceptualisation, visual memory in the right hemisphere cannot comprise the curtailed image that is created in the left hemisphere through perception.

There are, it seems, significant differences between the two hemispheres in the later top-down stages of visual processing, despite the fact that they both see the same visual image. But there is one feature that B-consciousness shares with C-consciousness – the phenomenon of visual illusion.

4.3.5 B-conscious visual illusion

In discussing the role of perception in the left hemisphere I made reference to a module which I named the Visual Analysis Module (VAM – see 4.2.4, 4.2.6 and Figure 4.2). The fact that illusions affect B-consciousness as well as C-consciousness indicates that a similar module must be located in the right hemisphere.

In the experiment which I reviewed in section 3.3.1, those patients who had brain damage to their left hemisphere, and thus were using only their right hemisphere, were equally affected by the Müller-Lyer illusion in both estimating and grasping (see Table 3.2). This could be taken as support for the view proposed by Milner & Dyde (2003) that illusions arise in the early stages of visual processing. The alternative view, and the one that I am adopting in this thesis, is that the VAM accounts for illusion.

In discussing perception and the left hemisphere I drew a distinction between the rich detailed analogue representation of the visual scene and the digital output of the Interpreter Module. In the former, two identical objects take up a different proportion of the visual field because one is further away than the other; in the latter, they are perceived as the same size because the Visual Analysis Module adjusts for perspective. I assume that the same arrangement applies in the right hemisphere, except that in this case there is no Interpreter Module, and the output of the VAM goes directly to B-consciousness.

This output explains why B-consciousness is as prone to illusion as C-consciousness. Under normal circumstances the VAM makes necessary and accurate adjustments to the visual input, and behaviour based on that output is successful. This may be why, when there is a conflict between the output of the ventral pathway via the VAM and the output of the dorsal pathway, we B-consciously choose the former (see 3.3.1).

SUMMARY: B-consciousness has the same susceptibility to visual illusion as C-consciousness, and this may arise from the presence of a Visual Analysis Module in the right hemisphere and well as in the left hemisphere.

4.3.6. Overview

I end this part of the chapter with a summary of what is involved in visual processing in the right hemisphere. I began by introducing the term ‘quaception’ (and the verb ‘quaceive’) to describe the process in the right hemisphere that corresponds to perception in the left hemisphere. The right hemisphere lacks concepts, and therefore lacks perception.

I suggested that quaception developed from the very simple responses to the environment that controlled reptilian behaviour before birds and mammals evolved. These responses could be seen as marking an early stage in the development of the emotions. Following the evolution of creature conscious, there is evidence that in humans an input to the amygdala via an older non-conscious visual pathway is accompanied by an input via the ventral pathway and B-consciousness. When both inputs agree, the amygdala initiates changes in the ***Autonomic Nervous System***.

The ventral visual pathway may reach B-consciousness via a module that I have termed the Visual Analysis Module (VAM), which is also found in the left hemisphere. This module adjusts the raw visual data provided by the ventral pathway for perspective and distance; it is therefore open to illusion. When the output of the VAM is inconsistent with the output of the dorsal pathway, we B-consciously choose the former. The result is that illusion affects B-conscious grasping as well as perceptual tasks performed B-consciously.

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The diagram below summarises the visual processes that take place in the right hemisphere.

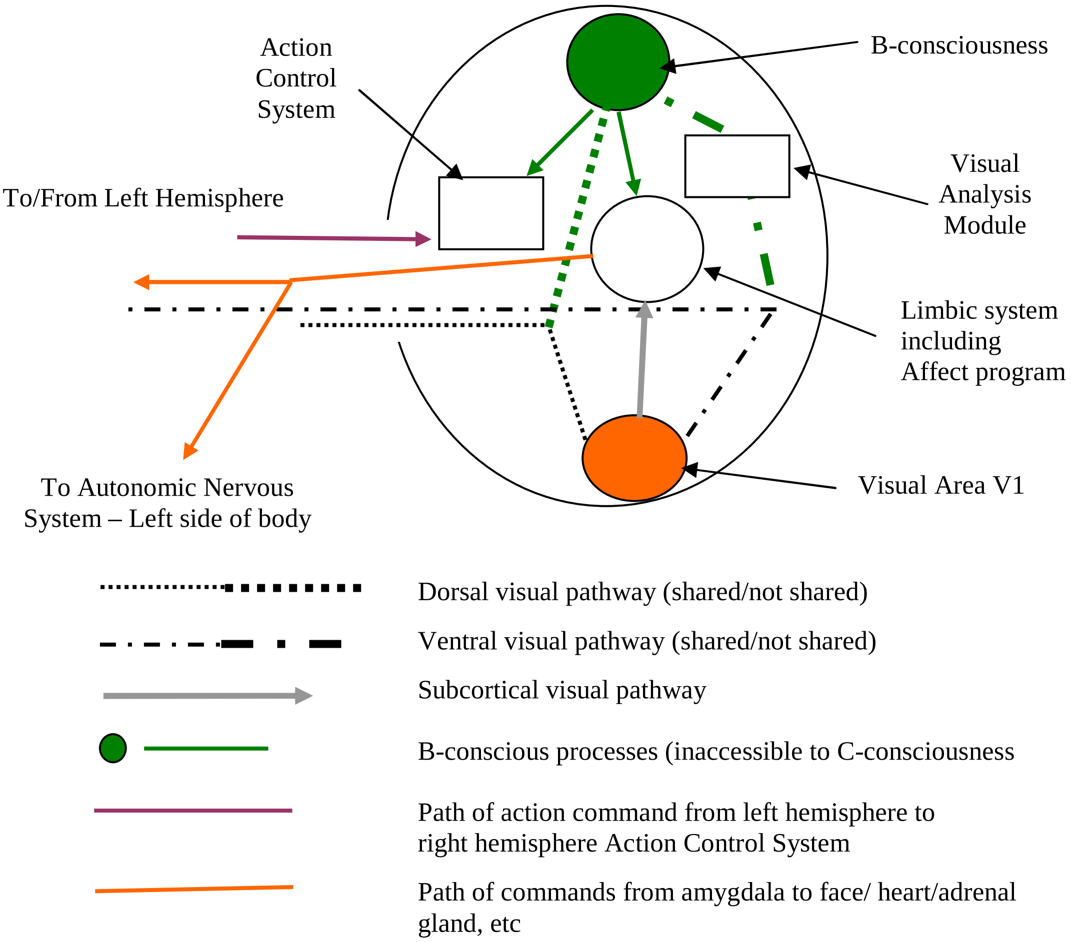

Figure 4.3 Visual Processing in the Right Hemisphere

4.4 Consciousness and vision: a summary

In this chapter I have considered how visual processing should be understood in the light of the dichotomies of two forms of consciousness, two visual pathways, and differing processes in the two cerebral hemispheres. I have claimed that traditional views in the philosophy of mind about perception fail to take these dichotomies into account. Any philosophical theories concerning human vision need to draw a clear distinction between sight – the bottom-up visual processing common to both hemispheres – and perception and quaception – the top-down visual processes in the left and right hemisphere respectively. Sight involves the rich detailed non-conceptual representations formed via the ventral pathway: perception involves a less detailed conceptualised representation of what is seen.

Perception and quaception differ in three important respects. Perception involves the conceptualisation of what is seen and the integration of that conceptualisation with other sources of information through the role of the Interpreter Module. That integration involves (a) the analysis of the visual data (by the Visual Analysis Module) to adjust for issues such as distance and perspective; (b) other sensory inputs – or sometimes the lack of such inputs; and (c) pre-existing beliefs and expectations. What is committed to memory in the left hemisphere is the perceptual representation and not the detailed non-conceptual representation.

Quaception involves the B-conscious placing of what is seen within a limited range of categories that has expanded through the course of human evolution, and that is linked to a range of bodily changes that are initiated in the amygdala. Other appropriate actions can also be inititated B-consciously. The fact that B-consciousness is prone to illusion shows that its visual input comes through a Visual Analysis Module (VAM) similar to that in the left hemisphere. Lacking B-conscious introspection, we cannot tell whether B-consciousness also receives the rich detailed non-conceptual analogue representation in parallel with the output from the VAM, but it does appear that B-consciously stored visual memories are richer and more detailed than C-consciously stored visual memories.

With this chapter I have completed the task of explaining and defending the six claims – three concerning human consciousness and three concerning human vision – that I set out in chapter 1. In the final chapter I will briefly consider the implications of these claims for other topics within the philosophy of mind.

CHAPTER 5

PROBLEMS, POSSIBILITIES AND PARALLELS

In the previous four chapters I have sought to explain and defend six specific claims, that arise out of the more general claim that philosophers of mind have, to a large extent, failed to take adequate account of the rapidly growing body of empirical evidence regarding human consciousness and vision. The claims are:

1. Humans have two separate centres of creature consciousness, one in each cerebral hemisphere.

2. The form of creature consciousness located in the right hemisphere – which I have termed B-consciousness – is the capacity to sense the environment and to respond with simple reasoning using the content of first order intentional states.

3. The form of creature consciousness located in the left hemisphere – which I have termed C-consciousness – is the capacity to sense the environment, to respond with complex reasoning using both first order and higher order intentional states, and to introspect and verbally report those states.

4. Humans see both B-consciously and C-consciously.

5. Seeing and perceiving are distinct stages in the processing of visual inputs, bottom-up and top-down respectively, and perceiving is limited to the left hemisphere.

6. Top-down visual processing in the right hemisphere is linked to emotion.

In this final chapter of the thesis I consider the implications of these claims for other topics within the philosophy of mind. My discussion of those topics is necessarily brief, and I focus on those aspects where the implications are immediately obvious. I begin with two issues where it may be thought that traditional views are challenged. These are the concept of the Unity of Consciousness, and the issue of personhood.

I then go on to two issues where the claims I have made may resolve disagreements or uncertainties. Views about emotions fall into two broad camps: the presence of two centres of consciousness with different abilities may explain the differences and provide a unifying approach. The problem of explaining self deception has led some philosophers to deny its existence: two centres of consciousness provide a simple explanation of how deception can arise, and how contradictory beliefs can coexist.

In the opening chapter I made brief reference to what has been termed “the Dual System (or Two Minds) Theory” (Evans & Frankish 2009). In this chapter I consider some parallels between that theory and the claims made in this thesis, and draw attention to some significant differences. I end the chapter, and the thesis, with a brief retrospective.

5.1 Two problems to be faced

In this part of the chapter I consider two topics where traditional views in the philosophy of mind appear to conflict with the presence of two distinct centres of consciousness. I will discuss the issue of personhood after I have considered the Unity of Consciousness. But before I tackle either subject, I raise a general point about the reliability of our introspective experience.

5.1.1 A problem with introspection

In this section I set out one of the implications that arise out of the presence of two visual pathways with very different roles. It forces us to reconsider what appears to be an obvious feature of our conscious experience, and to wonder whether other obvious features need to be questioned.

I look at the desk at which I am working on this thesis, and I see a rich and detailed scene. One of the objects on my desk I identify as a stapler, and that identification takes no account of the precise size and position of the stapler. I would have made the same identification if it were positioned elsewhere on the desk, or elsewhere in the room. But the rich and detailed non-conceptual content of my visual experience means that I can judge its size and position, and it seems obvious that it is that conscious judgment of size and position that enables me to stretch out my hand and pick up the stapler.

This is what Clark (2001) calls the “Assumption of Experience-Based Control”. He describes this assumption in the following terms:

> Conscious visual experience presents the world to the subject in a richly textured way, a way that presents fine detail (detail that may, perhaps, exceed out conceptual or propositional grasp) and that is, in virtue of this richness, especially apt for, and typically utilized in, the control and guidance of fine-tuned, real-world activity.
> (Clark 2001, p 496)

Clark goes on to point out that the empirical evidence, much of which I have set out in chapters 3 and 4 above, disproves this assumption. He proposes that it be replaced with the “Hypothesis of Experience-Based Selection”. This means, says Clark, that “conscious visual experience presents the world to a subject in a form appropriate for the reason-and-memory-based selection of actions” (ibid, p 512). This is the issue that I highlighted in chapter 3 (see section 3.2.3, distinction 2 and figure 3.6), where I showed that the decision to act, and the strategic planning stage of actions use data from the ventral pathway, before tactical planning and the control of action passes to the Action Command Module.

As I have set out in section 3.2.4 (distinction 3), there are a limited number of circumstances in which my actions are controlled by what I perceive, using visual data from the ventral pathway. Nevertheless, the empirical evidence is overwhelming for control in most cases drawing on visual data from the dorsal pathway of which I am not C-consciousness.

The point that I wish to make is that if the assumption of experience-based control, which seems to fit with our C-conscious introspection of our mental states, is so clearly wrong – then what other obvious assumptions underlying philosophical views on the human mind are also wrong? In the next two sections I consider two issues where I suggest that our assumptions – based on introspection – are unfounded.

SUMMARY: The assumption, based on introspection, that our conscious visual experience of our environment controls our actions is disproved by empirical evidence. What other assumptions based on introspection are wrong?

5.1.2 The Unity of Consciousness

In this section I consider the implications for the Unity of Consciousness of the presence of two forms of consciousness within the human mind/brain. My concern is not with the various theories that have been proposed to explain the unity, but with the assumption that there is unity. Could it be that in this case also an obvious assumption is unjustified?

At the heart of the concept of the unity of consciousness is what has been termed the “unified consciousness of contents” (Brook & Raymont 2006, p 5). This is the claim that there is a single unified consciousness of all my sensory inputs. My consciousness at this moment in time includes my visual awareness of my computer screen and all the other objects in the room, the sound of my wife moving about in the adjoining room, the pressure of the chair against my backside, and the ache in my left ankle. (I do not deny that there may be some sensory inputs such a smells of which I am unaware, and which do not form part of my unified consciousness.)

Brook and Raymont make the point that if there were not a unified consciousness then I would be unable to relate different elements in my perceptual experience. “If the consciousness of . . . two items were not unified, an important, indeed probably the most important, way of comparing them as they appear to me would not be available” (ibid). Bayne & Chalmers make the same point in these terms: “Necessarily, any set of conscious states of a subject at a time is unified” (Bayne & Chalmers 2007, p 2).

But – assuming that I am a single subject – consider my experience of driving on automatic pilot. I am C-conscious of my thoughts as I wrestle with complex philosophical concepts, and at the same time I am B-conscious of red traffic lights and B-consciously apply the brakes and bring the car to a halt. (See section 2.3.1 for the justification for my driving being [B-]conscious.) My consciousness of my thoughts and my consciousness of the red traffic lights are certainly not unified. I cannot think “I reached that conclusion just as the lights turned to red”.

Perhaps the problems can be solved by simply limiting the concept, and renaming it “the unity of C-consciousness”. This would deal with the issue of driving on automatic pilot, and offers the chance to explain unity by reference to the role of the Interpreter Module (see sections 2.1.6 and 4.2.4). But if we adopt this solution, what are we to make of the sleep walker (section 2.3.7)? I have claimed that in his case there is no C-consciousness, and there cannot therefore be any unified C-consciousness. But he shows a least some form of conscious unity when he is able to make his way around the furniture, pick up the envelope, make his way down the street, and post the envelope in a pillar box.

Perhaps we need to recognise two quite distinct concepts: the unity of C-consciousness and the unity of B-consciousness But this raises a further problem – the relationship between consciousness and the person – which will be the topic of the following section.

SUMMARY: The traditional view of the Unity of Consciousness is challenged by the presence of two different forms of consciousness in humans. It may be true that each form of consciousness is independently united, but if so it raises questions about personhood.

5.1.3 Personhood

I turn now to the implications of the claims that I have made for the philosophical understanding of personhood. I will not attempt to consider all the issues that underlie the concept of person, but will focus on some implications of dual consciousness.

“As Locke put it,” say Brook & Raymont (2006, p 14), “being the same person just is having the ‘same consciousness’”. Since Locke, they say, “diachronic unified consciousness has been closely linked to personal identity in the philosopher’s sense” (ibid). Closely linked to this line of thought is the role of memory, in two different ways (see Parfitt 1987, p 205). If I can remember what I did 20 years ago, then I am the same person as I was then. Alternatively, if I can remember what I did last year, and last year I could remember what I did the year before, and so on until I reach what I did 20 years ago, then that chain of memories shows that I am the same person as I was 20 years ago.

Both of these approaches to personhood are challenged by the existence of two forms of consciousness, each with their own access to memories. I cited a case in section 2.3.3 of a girl who retained a B-conscious memory of childhood abuse, to which at the time she had no C-conscious access. If she had no C-conscious memories of that time in her life, is she still the same person as she was then? And suppose she has C-conscious memories linking now to five years earlier and linking 10 years ago to 15 years ago, but only B-conscious memories linking five years ago to ten years ago – does that show that she is the same person?

Puccetti (1973, p339) describes the standard approach as thinking of “a human being as having a single brain, possessing a unitary mind, constituting a unique individual person”. But he goes on to reject this view, based on the experience of split-brain patients and of other individuals who had one hemisphere surgically removed. He comes to the conclusion that all brain-intact humans comprise not just two centres of consciousness, but two persons.

This is not a claim that I am making. But I am making the point that our idea of what constitutes a person requires major changes to incorporate the presence of two centres of consciousness in each human brain.

SUMMARY: The existence of two centres of consciousness in the human mind/brain, each with its own memory system, challenges two of the traditional approaches to individuating persons.

5.2 Two possibilities to be explored

In this part of the chapter I look at two issues in the philosophy of mind where the presence of two centres of consciousness may provide an explanation for topics on which there continue to be disputes. I begin by returning to the issue of the emotions, and continue the line of argument begun in section 4.3.3. I conclude this part of the chapter with the topic of self deception.

5.2.1 The emotions

In this section I describe the two broad camps into which philosophical views about the emotions can be divided. I continue the sequence of stages within an emotional experience outlined by Price (2005), the first four of which I discussed in section 4.3.3. I suggest how the presence of two forms of consciousness can reconcile the two camps and also fit into Price’s analysis of emotion.

Philosophical views about emotion fall into two broad camps. The following table sets out three major differences.

Camp 1	*Camp 2*
Emotions are innate and involuntary	Emotions are culturally acquired
Emotions are often irrational responses to stimuli	Emotions are rational assessments of stimuli
Emotions involve bodily changes	Emotions are the feeling of bodily changes

Table 5.1 Two views about the emotions

Solomon (2005, p 198) says that “emotions are taken to be the hallmark of the irrational”. Griffiths (1990, p 185) states that emotions “frequently occur when their occurrence is irrational in the light of our beliefs and desires”. There appear to be two distinct issues at play. The first is that the bodily changes associated with emotion can occur before I have the opportunity to C-consciously analyse the trigger. The second is that the changes may conflict with my C-conscious desires and beliefs.

In section 4.3.3, I outline the processes in the right hemisphere associated with emotions. In the case of a visual trigger, it is B-consciously seen – before awareness of the trigger reaches C-consciousness. The B-conscious sight of the trigger results in quaception, and the outcome of that process feeds into the amygdala. The amygdala initiates changes to the autonomic nervous system (ANS), and these changes may be accompanied by other changes initiated B-consciously. It is the ANS changes themselves that are understood by adherents to Camp 1 either as comprising the emotions, or as being the expression of emotions (Darwin 1872/1965).

One leading opponent of this view of emotion is James. In *The Principles of Psychology* he states that “the bodily changes follow directly the perception of the exciting fact, and . . . our feeling of the same changes as they occur IS the emotion” (James 1890, p 449, cited in Price 2005, p 194). He equates emotion with the fifth stage in Price’s analysis of emotions. Her eight stages are as follows (my terminology in brackets):

1. Eliciting event or situation (Trigger)
2. Perception of that event (Sight (or other sensory input) and quaception)
3. Processing of the information (in the amygdala)
4. Bodily changes
5. Feeling the bodily changes
6. Judging the significance of what is felt
7. Desire to respond to the judgement
8. Voluntary actions

I take it that what James is referring to (and Price, in her stage 5), relates to one aspect of the process that I have described in section 4.2.4 and figure 4.2. This is the process within the left hemisphere by which the Interpreter Module creates a theory that makes sense of all available sensory data, as well as stored beliefs and desires. Among the sensory data available to the Interpreter Module are the bodily changes initiated in the amygdala, as well as behaviour initiated B-consciously. It is the former that reach C-consciousness as perceptual input via the Interpreter Module, identified as a particular emotion.

Price’s stage 6 may be understood as comprising part of the work done by the Interpreter Module; that is the judgment of the significance of what is felt may reach C-consciousness already formed by the Interpreter Module. Alternatively, it may be a C-conscious judgment based on the input from that Module. In either case, the subsequent desire to respond (stage 7) results in behaviour that is initiated C-consciously (stage 8).

It will, I think, be clear that Price's stages 1 – 4 relate to activities in the right hemisphere associated with B-consciousness, with stage 4 including both ANS changes and B-conscious actions. Stages 5 – 8, and the views attributed to Camp 2, relate to left hemisphere activities associated with C-consciousness. This suggests that the presence of both B-consciousness and C-consciousness may provide the basis for a theory of emotion that explains and incorporates both camps.

Such a theory would reconcile such conflicting views as those of Ekman & Friesen (1971) and Averill (1980). The former compared the facial expressions associated with emotions in different societies, and showed a high degree of correlation, indicating that at least some basic emotions are innate. They also report that in some circumstances Japanese students consciously replaced the initial expression of emotion with a polite smile (cited in Griffiths 1990, p 179). This clearly puts them into Camp1.

Averill takes a quite different view and defines an emotion as "a transitory social role . . . that includes an individual's appraisal of the situation and that is interpreted as a passion rather than an action" (Averill 2005, p 254). This puts him into Camp 2.

These conflicting views can be understood as referring to right-hemisphere and left-hemisphere phenomena respectively, and are therefore not inconsistent.

SUMMARY: Philosophical view about emotion fall into two broad camps with sometimes contradictory views about what constitutes emotions and how they are acquired. These contradictions can be reconciled if the distinctive roles of the separate hemispheres, including B-consciousness and C-consciousness, are recognised.

5.2.2 Self-deception

In this section I consider two of the philosophical problems raised by the issue of self-deception, and show how the duality of human consciousness provides simple and convincing explanations. The first problem is intention: how can I intend to deceive myself? The second problem is belief. One common way of expressing self-deception is that it involves simultaneously believing p and believing $\neg$p: how is this possible?

The first problem can be resolved if we recognise that what we should be asking is "how can I be deceived by myself?". If we think of deception in the case of two people – A and B – then B can be deceived by A without any intention on A's part to deceive B. We do not have direct access to other people's thoughts – only to their actions. And actions can be misinterpreted. We are all familiar with American police dramas in which a suspect makes an innocent move, perhaps to take his identity card out of his pocket, and the policeman is deceived into thinking that the suspect has a gun. The end result is the death of the suspect.

In previous chapters I have shown that my B-conscious thought processes are not accessible to the Interpreter Module and to C-consciousness. The Interpreter Module can only observe behaviour that I initiate B-consciously, and make assumptions about the thinking that led to that behaviour. When those assumptions are wrong, then I am deceived C-consciously about my B-conscious motives, without any B-conscious intention to deceive.

Others may see the same B-conscious behaviour and make correct assumptions about the motives behind it, but then hear my C-conscious explanations for that behaviour. When they judge that those explanations are unjustified, they will conclude that I am deceiving myself.

A very similar situation arises when I C-consciously express a belief that I hold, but others can see that my behaviour gives evidence of the opposite belief. If I come to a B-conscious belief that p, the only way that I can become C-consciously aware of that B-conscious belief is by recognising its effect upon my B-conscious behaviour. If this does not happen, then there is no internal conflict if I come to form the C-conscious belief that ¬p. And since B-consciousness has no access to C-conscious thinking, there is no conflict in my continuing to hold the B-conscious belief that p. It is only when my actions give evidence of a B-conscious belief which I deny C-consciously, that the conflict becomes apparent and I am said to be self-deceived.

I should perhaps point out that in the majority of cases we are both B-conscious and C-conscious during perceptual experiences. It is therefore to be expected that any beliefs that arise B-consciously from an experience should also arise C-consciously, and it will be the exception rather than the rule for B-conscious beliefs and C-conscious beliefs to be in conflict.

SUMMARY: Two central problems in the philosophy of self-deception are explaining how I can intend to deceive myself, and how I can hold the belief that p simultaneously with the belief that ¬p. The first of these can be explained by C-conscious assumptions about B-conscious behaviour resulting in deception, without any intention to deceive. Secondly, beliefs can be formed B-consciously and C-consciously, and neither form of consciousness has access to the beliefs of the other form. Both problems are therefore resolved by the duality of human consciousness.

5.3 Claims about two minds

In chapter 1 (section 1.8.4), I made reference to the fact that there are certain parallels between (a) the claims that I am making about human consciousness and (b) what has been termed "The Dual System (or Two Minds) Theory". In this section I outline those parallels, before pointing out some significant differences. I end the section by stressing the danger of focussing on terminology, rather than on the facts described by that terminology.

5.3.1 The parallels

Evans (2009, p 34) summarises current views about two systems of human cognition by listing their characteristics[1]. System 1 is described as "evolutionarily old", "shared with animals" and "independent of language". All of these terms can also be applied to B-consciousness. System 2 is described as "evolutionarily recent", "distinctively human" and "associated with language". All of these terms apply equally to C-consciousness. However, he goes on to suggest that talk of two systems should be abandoned in favour of two minds.

> There are a number of reasons . . . why it may be a good idea to get away from the Systems 1 and 2 terminology. It would be more useful to describe this grand unifying form of dual-process theory as the 'two minds hypothesis' . . . Here I define 'mind' as a high-level cognitive system capable of representing the external world and acting upon it in order to serve the goals of the organism. The two minds hypothesis is that the human brain contains not one but two parallel systems for doing this. Animals, according to this view, have but one system corresponding to the 'old mind' in human beings. Humans have a second 'new' mind, which coexists in uneasy coalition with the first, sometimes coming into direct conflict with it. This is a strong, even startling hypothesis, which makes it very interesting (if probably wrong!). (Evans 2009, p 35)

In this passage Evans appears to be describing the claims that I make in this thesis, except that he uses the term 'mind' where I have chosen to use the term 'consciousness' (an issue to which I will return below). Apart from disagreeing with his final comment – that this hypothesis is probably wrong – why have I distinguished my claims from the two minds hypothesis? There are three reasons, which I will explain in the following sections.

SUMMARY: There are several very clear parallels between the two Systems described by Evans and the two forms of consciousness described in this thesis. Evans' description of the Two Minds Hypothesis strengthens the comparison, although he concludes that the hypothesis is probably wrong.

5.3.2 Different concepts of consciousness

The first major point to note is that Evans (ibid, p 34) describes the evolutionarily older System 1 as "unconscious, preconscious", and only System 2 as "conscious". This contrasts with my claims of two centres of consciousness. If System 1 is shared with

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[1] I have based my analysis on there being two misprints in Table 2.1 on page 34 of (Evans 2009), with the entries on rows 4 and 6 being inadvertently reversed. This has been confirmed in a personal communication from the author.

animals and is unconscious (or preconscious) then there are only two possible conclusions:

(1) Animals are not conscious.

(2) Animals are conscious, but when System 2 developed in humans, the consciousness inherited from our animal ancestors was lost, even though we retained all the abilities associated with that consciousness.

I will take the second possibility first. In chapter 1, I described the behaviours that we use to identify the presence of consciousness: sensing the environment, reasoning, learning and choosing. It is because animals display these abilities that we judge them to be [B-]conscious; what animals do not display are the [C-]conscious abilities to introspect, to use language to report their mental states, and to engage in abstract reasoning.

It makes no sense to find evidence of the same abilities in split-brain patients using their right hemisphere that are found in animals, but to declare that they are unconscious simply because they do not display the uniquely human abilities associated with C-consciousness. I therefore reject this possibility.

Turning now to the first possibility, there may be those who wish to define a concept of consciousness that has the effect of limiting consciousness to humans, and denying it to animals. Proponents of the Two System Theory do not deny that animals respond to their environment, nor that they are capable of reasoning (ibid); they simply deny that they do so consciously. This requires a much narrower conception of consciousness than I have adopted in this thesis, and limits consciousness to what I have termed ‘C-consciousness’.

The problem with this view is not in denying consciousness to animals, although many philosophers of mind view at least some animals as conscious. For example, Searle (2002, pp 61-62) explains why he judges his dog to be conscious. The problem arises when confronted with evidence from split-brain patients (see chapter 2). The behaviour of a split-brain patient using their left hemisphere meets the criteria for System 2’s concept of consciousness, but the same patient’s behaviour when using their right hemisphere fails to meet the criteria, and would therefore have to be classified as unconscious or preconscious.

It might be thought that the only difference between my claim for two centres of conscious and the Two Systems Theory is in the definition of the term ‘consciousness’. The consciousness associated with System 2 is consistent with my concept of C-consciousness. If this narrower concept of consciousness were adopted, then any behaviour that could not be viewed as C-conscious would, by definition, be unconscious (or possibly preconscious).

I take this view to be untenable, not only because of the problem of explaining the behaviour of split-brain patients, but also because of the explanatory power of two centres of consciousness for a wide variety of human behaviour (see part 2.3 of chapter 2, and sections 5.2.1 and 5.2.2 above).

SUMMARY: The Two Systems Theory views the evolutionarily older System 1 as unconscious or preconscious, and only System 2 as conscious. I have identified two forms of consciousness, with the older B-consciousness corresponding to System 1, and the more recent C-consciousness corresponding to System 2. Although it is possible to frame a narrower concept of consciousness, equivalent to my C-consciousness, I reject the claim that behaviour that I characterise as B-conscious can be understood as unconscious.

5.3.3 Hemispheric specialisation

In this section I point out a significant omission from the literature about the Two Systems Theory or the Two Mind Hypothesis. There is no mention of empirical evidence from split-brain patients, nor of the specialisation of the cerebral hemispheres revealed by that evidence.

In chapter 2 I summarised some of the differences that have been identified between mental processes in each of the cerebral hemispheres through tests on split-brain patients. Many of these differences overlap with differences identified between the proposed two systems in the human brain, such as speed of processing, type of reasoning, and association with language. Yet not one of the articles comprising (Evans & Frankish 2009) makes any mention of the extensive data on split-brain patients, some of which have been available for around half a century.

It may be this failure to take such data into account that leads Evans to the view that the Two Minds Hypothesis is probably false (Evans 2009, p 35). It may also explain the confusion that permeates (Evans & Frankish 2009) about whether there are two systems or three systems (Evans 2009, Stanovich 2009, Samuels 2009). Some of the distinctions that are made – between ways of thinking, for example – do not map onto the basic distinction between an evolutionarily older and an evolutionarily younger system, but are clearly differences within the latter system.

One essential difference therefore between my claims about two centres of consciousness, and the various forms of the Dual System Theory, is that the former is grounded in empirical evidence about the structure and organisation of the brain, especially as revealed in tests on split-brain patients, whilst the latter focuses mainly on evidence from psychology. (One exception is Carruthers (2009), who draws on the distinction between the two cortical visual pathways, although he makes no reference to the differing roles of the two hemispheres.)

SUMMARY: The proponents of the Two Systems Theory and the Two Minds Hypothesis make no mention of the empirical evidence about the different roles of the two hemispheres as revealed through tests on split-brain patients. Some of the distinctions that they make can be understood as differences within a system, rather than between systems.

In the next section I will consider one other difference between the claims made in this thesis and the Two Systems Theory – the use of the term ‘mind’.

5.3.4 A problem with mind

In this section I highlight the differences in the use of the term ‘mind’ in this thesis and in (Evans & Frankish 2009). I explain why I have largely avoided use of the term, and have focused instead on creature consciousness.

In chapter 1 (part 1.3), I rejected the Cartesian concept of mind as a substance, and outlined two possible senses of the term – using the analogy of school and education. If mind is understood in the latter sense, then it makes no sense to discuss how many minds we have. But if used in the former sense, then we require criteria in order to be able to individuate minds. Before I pursue this point, an expansion of the school analogy may be helpful.

St David’s is a long-established boys’ school for pupils aged 11-18, housed in an Elizabethan mansion. A few years ago it was reorganised into a Lower School, for pupils aged 11-14 and an Upper School for pupils aged 14-18. The long-serving Head Master of St David’s was appointed Head Master of the Lower School, and a new Head Master was appointed to the Upper School. One wing of the building is used mainly by the Lower School and one wing mainly by the Upper School; the central part of the building provides common services including science and sports facilities. Because contact with parents tends to focus on GCSE and ‘A’ level exams and on university entrance, parents see much more of the Head Master of the Upper School, and many assume that he is Head Master of St David’s. There has been a long-running dispute as to whether St David’s is one school or two, with the teacher unions arguing that two Head Masters means two schools, whereas the governors argue that St David’s continues to be a single school.

In Two Minds (Evans & Frankish 2009) opens with a paper in which the authors “explore the idea that there is a fundamental duality in the human mind” (Frankish & Evans 2009, p 1). However, in the next paper Evans talks about humans having both an “old mind” and a “new mind” (Evans 2009, p 35). In so doing, he defines ‘mind’ as “a high-level cognitive system capable of representing the external world and acting upon it in order to serve the goals of the organism” (ibid).

The parallels with the school analogy are clear, and it might be possible to make a case for using ‘mind’ both of the totality of the mental processes within one human brain, and also of two distinct sets of processes, each comprising “a high-level cognitive system”. But in the very next paper, Stanovich (2009) complicates the picture. He first makes the point that what is commonly called “System 1” should really be viewed as a set of systems, and then identifies two levels of processing within System 2: the reflective and the algorithmic. Finally, making reference to Dennett’s (1996) book *Kinds* *of minds*, he suggests that humans have three minds: the reflective mind, the algorithmic mind, (both associated with System 2) and the autonomous mind (which is a renaming of System 1).

It was in the light of such inconsistencies in usage of the term ‘mind’ that I chose to focus on creature consciousness. It may be that the presence of two centres of consciousness means two minds, in the same way that having two head masters means two schools. But it is also possible that one mind could be divided into two sections, each controlled by a centre of consciousness. My concern was that disagreement about the meaning of terms would divert attention from the underlying features to which the terms are applied.

SUMMARY: My claim is that there is a duality in human consciousness and human cognition, arising from essential differences between mental processes in the two cerebral hemispheres, not that there are two minds (although I have no principled objection to that terminology). The collections of views described as the Dual Systems Theory cannot agree whether they are discriminating between processes, or systems, or minds; nor whether there are two, three or more of them – whatever they are. This is the third essential difference between that Theory and what I am claiming.

5.4 Conclusion

The underlying theme of this thesis has been that philosophers of mind have failed to pay adequate attention to empirical evidence about the structure and organisation of the human brain. That evidence, some of which has been available for fifty years, reveals two essential dualities at the heart of the human brain: two centres of consciousness – one in each cerebral hemisphere – and two cortical visual pathways – one serving the identification of objects in our visual field, and the other controlling our bodily actions in respect of those objects.

I have claimed (a) that the form of consciousness in the right hemisphere, which I have termed B-consciousness, is inherited from our animal ancestors, and comprises the capacity to sense the environment and respond with simple reasoning using the content of first order intentional states; and (b) that the form of consciousness in the left hemisphere, which I have termed C-consciousness, is uniquely human, developed alongside language, and comprises the capacity to sense the environment, to respond with complex reasoning using both first order and higher order intentional states, and to introspect and verbally report those states. I have also claimed that the co-existence of B-consciousness and C-consciousness provides the best explanation for (a) the widespread phenomenon of driving on automatic pilot; (b) the experience of having responded to a threat even before we become aware of it; (c) the way that our behaviour can be influenced by beliefs, desires, or memories that we are not aware of; (d) the confabulation that we sometimes fall back on to explain our behaviour; and (e) how sleep and consciousness are related.

Although there is clear evidence from neuro-imaging of two cortical visual pathways, there continues to be disagreements about the detailed implications. I have made claims about the relationship of the two visual pathways to the two centres of consciousness, with C-consciousness being served only by the ventral pathway, whereas B-consciousness is served by both pathways. I have refuted some attempts to challenge the evidence for separate visual pathways for perception and action, pointing out the difference between the visual pathways themselves and the processes served by those pathways. I have also shown that some actions do indeed make use of visual data from the ventral pathway and not the dorsal. These actions are:

(a) Actions that a quasi-linguistic in nature and convey information about an object rather than acting on the object;

(b) Actions that are directed at a point in space that has to be C-consciously calculated;

(c) Actions that involve movements for which no schema is currently available, and which therefore depend upon conscious control of movements; and

(d) That proportion of any other object-directed action in respect of which vision is disabled at some point between initiation and completion.

The existence of these two dualities at the heart of the human mind/brain challenge many central ideas in the philosophy of mind. Is there any validity in the concept of the unity of consciousness? What are the implications of two centres of consciousness – each with its own beliefs, desires, memories, and cognitive processes – for our understanding of the mind, and of persons? If the visual system that controls my movements when I pick up my coffee cup is not the same as the visual system which enables me to identify that it is a coffee cup, and which makes me visually aware of what I am doing when I pick up the cup, then what other “obvious” introspectable experiences are not what they seem? I have made the case for separating seeing from perceiving, denying the standard view that ‘seeing’ is a perceptual term. I have also claimed that perception is limited to C-consciousness, and that we require a different way of understanding the B-conscious process that results from seeing.

My focus has been on creature consciousness, and I have questioned whether it is appropriate to apply the term ‘conscious’ to mental states. This puts me at odds with much of the literature of the past fifty years in which consciousness has been viewed as primarily applying to mental states. It also differentiates my claim for two centres of consciousness from that of Block (2005), since he talks in terms of the difference between “access consciousness” and “phenomenal consciousness”, both of which are essentially mental state forms of consciousness (Block 1997).

If it is accepted that the terms “access consciousness” and “phenomenal consciousness” can be applied to creature consciousness, then both B-consciousness and C-consciousness are forms of access consciousness, since they both enable us to reason and to control action (Block 1997, p 382). I have, however, denied that there is any sense in which our B-conscious sensory inputs can be described in terms of “what it is like” for us to process them (see chapter 1, section 1.7.1). Only C-consciousness could therefore be viewed as a form of phenomenal consciousness, but in conceding this possibility I am not committing to the concepts of phenomenal properties or qualia, since I doubt their existence.

I conclude this summary of my claims by returning to my central point: that philosophers have to a large extent either been ignorant of, or have chosen to ignore, some empirical evidence that challenges traditional views about human consciousness and human vision. The scope of science has been expanding exponentially for several centuries, one result of which is the development of narrower and narrower specialisations. It becomes increasingly difficult for the philosopher of mind to keep pace with developments in other aspects of philosophy, let alone developments in all the other fields with an interest in the human brain and the human mind.

Despite these problems, philosophy must continue to be informed by empirical findings, from whichever branch of science they come. To fail to do so is to risk philosophy being sidelined, and being dismissed as no longer relevant, or even dead – as claimed by Hawking & Mlodinow in their recent book (cited in Wojcik 2010, p 1).

APPENDIX

GLOSSARY OF NEUROLOGICAL TERMS

Amygdala	A part of the **limbic system**. It is the source of commands to the body that control emotional responses.
Autonomic Nervous System	The system that controls such things as heart rate, breathing, digestion, and various glands (including the tear glands).
Brainstem	The oldest part of the brain that controls automatic processes such as breathing and heartbeat.
Cerebellum	The "little brain" that links into the **brainstem** below the **cortex**.
Cerebral	Relating to the **cerebrum**.
Cerebrum	The main part of the human brain, comprising the two **cerebral** hemispheres.
Commissurotomy	An operation to sever the **corpus callosum**, usually to prevent or reduce epileptic seizures.
Corpus callosum	The bundle of nerve cells that link the two cerebral hemispheres.
Cortex	Usually refers to the **neocortex**, the most recently evolved outer part of the brain. It is divided into two hemispheres, each of which comprises four **lobes**.
Cortical	Relating to the **cortex**.
Forebrain	Another term for the **limbic system**, that part of the brain that evolved to control behaviour in reptiles.
Frontal Lobe	The area of the cortex at the front of the brain. It is the site of many higher functions, and has been described as "the executive brain" (Goldberg 2001).
Fusiform Face Area	An area within the **temporal lobe** of the right hemisphere, known as the **fusiform gyrus**, that is specialised for face recognition.
Fusiform gyrus	A part of the **temporal lobe**, from the Latin 'fusus' meaning spindle, because of its shape.
Hippocampus	Part of the **limbic system**.

Limbic system	Those areas of the brain, including the **amygdala,** the **hippocampus** and the **thalamus**, that formed the **forebrain** in reptiles, and in humans controls the **autonomic nervous system**.
Lobe	One of four areas within each cerebral hemisphere. The lobes are separated by deep fissures.
Neocortex	The most recently evolved part of the **cortex**, often simply called the **cortex**.
Occipital Lobe	The area of the cortex at the rear of the brain. Visual processing begins in area V1 in this **lobe**.
Parietal Lobe	The area of the cortex between the **occipital** and **temporal lobes**. The dorsal visual pathway terminates in this lobe.
Subcortical	Involving an older part of the brain, below the **neocortex**.
Temporal Lobe	The area of the cortex behind the temples, ie between the **frontal** and **parietal lobes**. The ventral visual pathway terminates in this lobe.
Thalamus	Part of the **limbic system**.

NOTE: Except where otherwise attributed, the information in this appendix is drawn from Gazzaniga et al (2002) and Joseph (1996).

REFERENCES

Aglioti S, DeSouza J F X & Goodale M A (1995) ‘Size-contrast illusions deceive the eye but not the hand’ in *Current Biology,* Vol. 5, pp 679-685

Armstrong, D M (2004) ‘What is consciousness?’ in Heil, J *Philosophy of Mind: a guide and anthology,* Oxford, Oxford University Press

Averill, J (1980) ‘A constructivist view of emotions’ in Plutchnik, R & Kellerman, H (eds) *Theories of Emotion,* New York, Academic Press

Baldwin M W, Carrell S E & Lopez D F (1990) ‘Priming Relationship Schemas: My Advisor and the Pope Are Watching Me from the Back of My Mind’ in *Journal of Experimental Social Psychology,* Vol. 26, pp 435-454

Bayne, Tim & Chalmers, David J (2007) *What is the Unity of Consciousness?* downloaded from http://consc.net/papers/unity.html on 25/02/07

Bermúdez, J L (2003) *Thinking Without Words,* Oxford, Oxford University Press

Bermúdez, José Luis (2005) *Philosophy of Psychology: a contemporary introduction,* New York, Routledge

Bermúdez, J L (2007) ‘From Two Visual Systems to Two Forms of Content?’ in *Psyche,* Vol. 13, pp 1-7

Block, Ned (1997) ‘On a Confusion about a Function of Consciousness’ in Block et al *The Nature of Consciousness: Philosophical Debates*, Cambridge Mass, The MIT Press

Block, Ned (2005) ‘Two neural correlates of consciousness’ in *Trends in Cognitive Sciences,* Vol 9 No 2, pp 46-52

Block, Ned, Flanagan, Owen & Güzeldere, Güven (1997) *The Nature of Consciousness: Philosophical Debates,* Cambridge Mass, The MIT Press

Brook, Andrew & Raymont, Paul (2006) ‘The Unity of Consciousness’ in *Stanford Encyclopedia of Philosophy,* downloaded on 25/02/07 from http://plato.stanford.edu/entries/consciousness-unity

Bruno, N & Franz, V H (2009) ‘When is grasping affected by the Müller-Lyer illusion? A quantitative review’ in *Neuropsychologia,* Vol. 47, pp 1421-1433

Burgess N, Jeffery K J & O’Keefe J (1999) *The hippocampal and parietal foundations of spatial cognition,* Oxford, Oxford University Press

Byrne, R W (1995) *The Thinking Ape,* Oxford, Oxford University Press

Carruthers, Peter (2000) *Phenomenal Consciousness,* Cambridge, Cambridge University Press

Carruthers, Peter (2009) ‘An architecture for dual reasoning’ in Evans, J St B T & Frankish, K (eds) *In Two Minds: Dual Processes and Beyond,* Oxford, Oxford University Press

Chalmers, David J (2004) ‘Facing up to the problem of consciousness’ in Heil *Philosophy of Mind: a guide and anthology,* Oxford, Oxford University Press

Clark, A (2001) ‘Visual Experience and Motor Action: Are The Bonds Too Tight?’ in *Philosophical Review,* Vol. 110, pp 495-519

Clark, A (2007) ‘What Reaching Teaches: Consciousness, Control, and the Inner Zombie’ in *The British Journal for the Philosophy of Science,* Vol. 58, pp 563-594

Clark, A (2009) ‘Perception, action, and experience: Unravelling the golden braid’ in *Neuropsychologia,* Vol. 47, pp 1460-1468

Connolly J D, Andersen R A & Goodale M A (2003) ‘FMRI evidence for a “parietal reach region” in the human brain’ in *Experimental Brain Research,* Vol. 153, pp 140-145

Damasio, Antonio (2006) *Descartes’ Error: Emotion, Reason and the Human Brain* (revised p/b edition), London, Vintage Books

Darwin, Charles (1872/1965) *The Expression of Emotion in Man and Animals,* Chicago, University of Chicago Press

Davidson, D (1978) ‘Intending’ in Yovel, Y (Ed) *Philosophy of History and Action,* Dordrecht, Reidel

Dennett, D C (1996) *Kinds of Minds: Toward an understanding of consciousness,* New York, Basic Books

Edelman, Gerald M (2006) *Second Nature: Brain Science and Human Knowledge,* New Haven, Yale University Press

Ekman, P & Friessen, W V (1971) ‘Constants Across Cultures in the Face and Emotion’ in *Journal of Personality and Social Psychology,* Vol. 17(2) pp 124-129

Evans, J St B T (2009) ‘How many dual-process theories do we need? One, two or many?’ in Evans, J St B T & Frankish, K (eds) *In Two Minds: Dual Processes and Beyond,* Oxford, Oxford University Press

Evans, Jonathan St B T & Frankish, Keith (2009) *In Two Minds: Dual Processes and Beyond,* Oxford, Oxford University Press

Frankish, Keith & Evans, Jonathan St B T (2009) ‘The duality of mind: An historical perspective in Evans, J St B T & Frankish, K (eds) *In Two Minds: Dual Processes and Beyond,* Oxford, Oxford University Press

Franz V H, Hesse C & Kollath S (2009) ‘Visual illusions, delayed grasping, and memory: No shift from dorsal to ventral control’ in *Neuropsychologia,* Vol. 47, pp 1518-1531

Gazzaniga, M S (2000) ‘Cerebral specialization and interhemispheric communication: Does the corpus callosum enable the human condition?’ in *Brain*, Vol 123, pp 1293-1326

Gazzaniga M S, Ivry R B & Mangun G R (2002) *Cognitive Neuroscience: The biology of the mind* (2nd ed), New York, W W Norton & Company Inc

Goldberg, Elkhonon (2001) *The Executive Brain: Frontal Lobes and the Civilized Mind*, New York, Oxford University Press

Gonzalez C L R, Ganel T & Goodale M A (2006) ‘Hemispheric Specialization for the Visual Control of Action is Independent of Handedness’ in *Journal of Neurophysiology,* Vol. 95, pp 3496-3501

Gonzalez C L R, Ganel T, Whitwell R L, Morrissey B & Goodale M A (2008) ‘Practice makes perfect, but only with the right hand: Sensitivity to perceptual illusions with awkward grasps decreases with practice in the right hand but not the left hand’ in *Neuropsychologia,* Vol. 46, pp 624-631

Goodale, M A & Milner, A D (1992) ‘Separate visual pathways for perception and action’ in *Trends in Neuroscience,* Vol. 15, No. 1, pp 20-25

Goodale, Melvyn A (2008) 'Action without perception in human vision' in *Cognitive Neuropsychology,* Vol 25, pp 891-919

Griffiths, P E (1990) ‘Modularity, and the Psychoevolutionary Theory of Emotion’ in *Biology and Philosophy,* Vol. 5 pp 175-196

Güzeldere, Güven (1997) *‘The Many Faces of Consciousness: A Field Guide’* in Block et al *The Nature of Consciousness: Philosophical Debates*, Cambridge Mass, The MIT Press

Hawking, Stephen & Mlodinow, Leonard (2010) *The Grand Design*, New York, Bantam Books

Haywood, Lynsey (2009) ‘US dicephalus twins who defied all medical odds to live’ in *The Sun* 12th January 2009, downloaded from hhttp://thesun.co.uk/sol/homepage/news/article2120555.ece on 13/08/2010

Heil, John (2004) *Philosophy of Mind: a guide and anthology,* Oxford, Oxford University Press

Hesse, C & Franz, V H (2009) ‘Memory mechanisms in grasping’ in *Neuropsychologia,* Vol. 47, pp 1532-1545

Himmelbach M, Nau M, Zündorf I, Erb M, Perenin M-T & Karnath H-O (2009) 'Brain activation during immediate and delayed reaching in optic ataxia' in *Neuropsychologia,* Vol. 47, pp 1508-1517

Horowitz, Norman H (1997) *Roger Wolcott Sperry* downloaded from http://nobelprize.org/nobel_prizes/medicine/articles/sperry/index.html on 04/07/2010

Jacob, P & Jeannerod, M (2003) *Ways of Seeing: The scope and limits of visual cognition,* Oxford, Oxford University Press

James, W (1890) *The Principles of Psychology,* New York, Dover

Joseph, R (1996) *Neuropsychiatry, Neuropsychology, and Clinical Neuroscience* (2nd Edition), Baltimore, Williams & Wilkins

Joseph, Rhaun (2008a) *Conscious Awareness* downloaded from www.brainmind.com/ ConsciousAwareness.html on 03/03/2008

Joseph, Rhaun (2008b) *Well Kept Secrets: Right Brain Memories* downloaded from www.brainmind.com/ RightBrainAwareness.html on 03/03/2008

Koch, C & Crick, F (2001) 'The Zombie Within" in *Nature* Vol. 411, p 893

Kuhn, Thomas (1970) *The Structure of Scientific Revolutions* (2nd Ed), Chicago, University of Chicago Press

Lewis, David (1997) 'What Experience Teaches' in Block et al *The Nature of Consciousness: Philosophical Debates,* Cambridge Mass, The MIT Press

Lowe, E J (2000) *An Introduction to the Philosophy of Mind,* Cambridge, Cambridge University Press

Lycan, William G (1997) 'Consciousness as Internal Monitoring' in Block et al *The Nature of Consciousness: Philosophical Debates,* Cambridge Mass, The MIT Press

McGinn, Colin (1997) 'Can We Solve the Mind-Body Problem?' in Block et al *The Nature of Consciousness: Philosophical Debates*, Cambridge Mass, The MIT Press

Melmoth D R, Tibber M S, Grant S & Morgan M J (2009) 'The Poggendorf illusion affects manual pointing as well as perceptual judgments' in *Neuropsychologia,* Vol. 47, pp 3217-3224

Milner A D, Dijkerman H C & Carey D P (1999) 'Visuospatial processing in a pure case of visual-form agnosia' in Burgess et al (eds) *The hippocampal and parietal foundations of spatial cognition,* Oxford, Oxford University Press

Milner, A D & Goodale, M A (2006) *The Visual Brain in Action* (2nd ed), Oxford, Oxford University Press

Milner, A D & Dyde, R (2003) 'Why do some perceptual illusions affect visually guided action, when others don't?' in *Trends in Cognitive Sciences,* Vol. 7, pp 10-11

Mole, Christopher (2009) 'Illusions, Demonstratives, and the Zombie Action Hypothesis' in *Mind,* Vol. 118, pp 995-1011

Morris, Steven (2009) 'Devoted husband who strangled wife in his sleep walks free from court' in *The Guardian* 20th November 2009, downloaded from http://www. guardian.co.uk/2009/nov/20/brian-thomas-dream-strangler-tragedy on 07/07/2010

Nagel, Thomas (1971) 'Brain Bisection and the Unity of Consciousness' in *Synthese,* Vol. 22, pp 396-413

Nagel, Thomas (1997) 'What Is It Like To Be a Bat?' in Block et al *The Nature of Consciousness: Philosophical Debates,* Cambridge Mass, The MIT Press

Nisbett, Richard E & Wilson, Timothy D (1977) 'Telling More Than We Can Know: Verbal Reports on Mental Processes' in *Psychological Review,* Vol. 84, pp 231-259

O'Regan, J K (2010) 'Change Blindness' in *Encyclopedia of Cognitive Science* downloaded from http://nivea.psycho.univ-paris5.fr/ECS/ESC-CB.html on 07/09/2010

Parfitt, Derek (1987) *Reasons and Persons* (paperback reprint with corrections), Oxford, Oxford University Press

Penfield, W (1975) *The Mystery of the Mind: A Critical Study of Consciousness and the Human Brain,* Princeton NJ, Princeton University Press

Price, Carolyn (2005) *Emotion*, Milton Keynes, The Open University

Prinz, Jesse (2004) *Gut Reactions: A Perceptual Theory of Emotion,* Oxford, Oxford University Press

Puccetti, Roland (1973) 'Brain Bisection and Personal Identity' in *The British Journal for the Philosophy of Science*, Vol. 24, pp. 339-355

Radoeva P D, Cohen J D, Corballis P M, Lukovits T G & Koleva S G (2005) 'Hemispheric asymmetry in a dissociation between the visuomotor and visuoperceptual streams' in *Neuropsychologia*, Vol. 43 pp 1763-1773

Robertson, Ian (1999) *Mind Sculpture: your brain's untapped potential,* London, Bantam Press

Rosenthal, David M (1997) 'A Theory of Consciousness' in Block et al *The Nature of Consciousness: Philosophical Debates*, Cambridge Mass, The MIT Press

Samuels, Richard (2009) 'The magical number two, plus or minus: Dual-process theory as a theory of cognitive kinds' in Evans, J St B T & Frankish, K (eds) *In Two Minds: Dual Processes and Beyond,* Oxford, Oxford University Press

Schneider, G E (1969) ‘Two Visual Systems’ in *Science,* Vol 163, pp 895-902

Searle, John R (1990) ‘Who is computing with the brain?’ in *Behavioural and Brain Sciences,* Vol 13, pp 632-642

Searle, John R (1992) *The Rediscovery of the Mind*, Cambridge MA, The MIT Press

Searle, John R (1994) *The Rediscovery of the Mind* (pbk ed), Cambridge MA, MIT Press

Searle, John R (2002) *Consciousness and Language*, Cambridge, Cambridge University Press

Searle, John R (2007) ‘Dualism Revisited’ in *Journal of Physiology Paris*, Vol 101, pp 169-178

Solomon, Robert C (2005) ‘Emotions and Choice’ in Price, C *Emotion,* Milton Keynes, The Open University

Soon C S, Brass M, Heinze H-J & Haynes J-D (2008) ‘Unconscious determinants of free decisions in the human brain’ in *Nature Neuroscience* published online on 13/04/2008 and downloaded from http://www.nature.com/natureneuroscience on 14/04/2008

Sperry, Roger W (1981) *Some Effects of Disconnecting the Cerebral Hemispheres (Nobel Lecture)* downloaded from http://nobelprize.org/nobel_prizes/medicine/laureates/1981/sperry-lecture.html on 04/07/2010

Stanovich, K E (2009) ‘Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory?’ in Evans, J St B T & Frankish, K (eds) *In Two Minds: Dual Processes and Beyond,* Oxford, Oxford University Press

Swoyer, Chris (2003) ‘Relativism and the Constructive Aspects of Perception’ in *Stanford Encyclopedia of Philosophy,* downloaded from http://plato.stanford.edu/entries/relativism/supplement1.html on 08/09/2010

Tye, Michael (2004) ‘Précis of *Ten Problems of Consciousness*’ in Heil *Philosophy of Mind: a guide and anthology,* Oxford, Oxford University Press

Van Gulick, R (1989) ‘What difference does consciousness make?’ in *Philosophical Topics,* Vol. 17, pp 211-230

Weizkrantz, L (1986) *Blindsight: A Case Study and Implications,* Oxford, Oxford University Press

Weiskrantz, L (1987) ‘Residual Vision in a Scotoma’ in *Brain,* Vol. 110, pp 77-92

Wojcik, John (2010) ‘Philosophy is dead, asserts Stephen Hawking in new book’ downloaded from www.peoplesworld.org on 17/09/2010