The Use of Focus Cues in Healthy Ageing

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ABSTRACT

It is known that general processing resources decline with age (Craik, 1983), yet language comprehension typically remains well preserved in normal aging (Wingfield & Grossman, 2006). It is well known that placing a concept within the scope of focus either with syntactic devices or prosody increases the salience of the text information (e.g., Birch & Rayner, 1997; Cutler & Fodor, 1979; Baker & Wagner, 1987; Cooreman & Sanford, 1996; Sturt, Sanford, Stewart & Dawydiak, 2004). Since information structuring cues are used over a lifetime, it is possible that it is preserved as a cue in older adults and that it may be used to offset other processing difficulties. However, focus may be considered a linguistic equivalent of devices for manipulating selective attention, and there is evidence that older people have difficulties with some selective attention tasks, and have difficulties with the inhibition of irrelevant stimuli. It is thus difficult to predict how older people might respond to focus cues during language processing. There is no evidence regarding this question, and the present thesis contains work aimed at an answer.

This thesis presents a series of studies, including sentence continuation studies, self-paced reading studies, delayed probe recognition and eye-tracking studies, and one change detection study investigating the effect of focus and related cues on an older age group. The main findings are older adults showed in some cases larger effects of focus and subordination, in terms of reading times, change detection and probe recognition rates, than did their younger counterparts. However, older and younger participants have different processing patterns based on the proper name/role description contrast, unlike

the findings from the information structuring cues. These findings are discussed in

relation to existing research on how healthy adult ageing modulates language processing.

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I would like to dedicate this thesis to the memory of my father James Price, my auntie Eileen James and my uncle James Allen.

Declaration

I declare that this thesis is my own work carried out under the normal terms of
supervision.

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CONTENTS

CHAPTER 1: GENERAL INTRODUCTION TO LANGUAGE PROCESSING

AND ADULT AGEING

INTRODUCTION

The most obvious signs of aging are changes in physical appearance, such as wrinkles and the greying of the hair. Other changes include the slowing down of actions, followed by restrictions in movement, and being more prone to chronic illnesses (such as hypertension, rheumatism, osteoporosis, heart disease, diabetes and asthma (e.g., Oskvig, 2005). This reduces the reserve capacity an older individual has to cope with everyday tasks, stresses, and drug metabolism (that result in a delay in clearing drug effects). Yet life expectancy on average has nearly doubled since the beginning of the 20th century and the population over the age of 65 years is the fastest growing age group (Oskvig, 2005).

It is known that general processing resources decline with age (Craik, 1983) and deficits appear when processing time is limited or memory demands are high (Hamm & Hasher, 1992). Evidence of impairments of older adults' performance tends to be based on terms of their ability to memorise and recall information in the text (DeBeni, Borella, & Carretti, 2007). A possible confound is the fact some reading studies involves the materials being presented word-by-word rather than the more natural line-by-line.

However, language comprehension typically remains well preserved in normal aging (Wingfield & Grossman, 2006) and language skills are considered relatively resistant to decline (e.g., Kliegl, Mayr, Junker, & Fanselow, 1999). Baltes (1997) argues that reading comprehension is part of the so-called crystallized pragmatic abilities which are maintained up to and over 75 years of age (Baltes, 1997; Baltes & Mayer, 1999; Baltes & Smith, 2003).

What is intriguing is the fact language comprehension remains relatively stable even though older adults display declines in a wide range of cognitive resources. It is of major importance that not all age-related changes are negative; it is well known that a person's vocabulary continues to grow with age; older adults have larger vocabularies than younger ones (e.g., Verhaeghen, 2003). Older adults tend to yield superior performance on the National Adult Reading Test (Nelson, 1985), which requires pronunciation of irregular spelled words such as *superfluous* (e.g., Uttl, 2002; Burke & Shafto, 2008). Although older adults demonstrate deficits in a variety of areas, several studies have clearly shown that there are only very minor age differences in semantic processing (Federmeier, 2003, Mayr & Kliegl, 2000; Radvansky, Zwaan, Curiel & Copeland, 2001), and in some cases the findings indicate larger semantic priming effect sizes for older adults (e.g, Laver & Burke, 1993; Madden, 1988, Thornton & Light, 2006).

In the ageing literature, there are at least seven approaches that aim to explain the age-related deficits in cognition such as: general slowing in processing (e.g., Salthouse, 1992; 1996); working memory deficits that reduce the ability to store and manipulate information (Carpenter, Miyake & Just, 1994); the weakening of inhibitory processes (e.g., Hasher & Zacks, 1988); the transmission deficit hypothesis (e.g., Mackay & Burke, 1990); neurological changes in brain (e.g., West, 1996); attentional resource deficits (e.g., Plude & Hoyer, 1995) and sensory/perceptual deficits (e.g., Schneider & Pichora-Fuller, 2000; Sciafla, 2002). I will begin by providing a brief overview of four of the cognitive ageing models that relate to cognition in general. Recent studies exploring age-related deficits in language comprehension tend to focus on a specific resource i.e., speed,

inhibition or working memory and I will explore these in greater depth. However, this

thesis is not looking to focus on a specific model that might explain how healthy adult

ageing modulates text comprehension. Many of the models of cognitive aging are often

too general to account for the diverse range of results in the literature (Thornton & Light,

2006).

<div align="center">Ageing and standard accounts of comprehension</div>

Transmission deficit hypothesis

The transmission deficit hypothesis is linked to the Node Structure theory, where

inhibitory and excitatory interactions occur in parallel between 'nodes' in a

interconnected network (MacKay & Burke, 1990). Some nodes represent higher

cognitive components that represent semantic and grammatical information, or

phonological and orthographic information. Sensory analysis represents the ability to

perceive speech and muscle movement nodes which represent the ability to produce
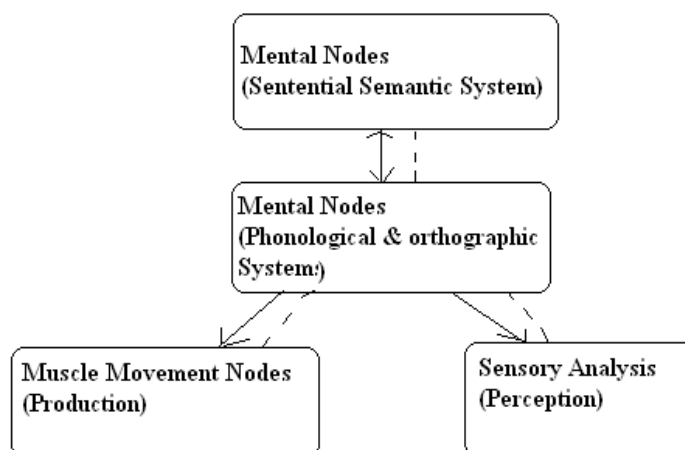
speech (see figure 1.1).

Figure 1.1 Adapted from Mackay and Burke (1990)

The connections between the nodes in the network are strengthened by frequency and recency of use (activation levels). The Transmission deficit account predicts that many age-related changes in cognition are due to weakened connections among memory representations that result in reduced transmissions of excitation (Burke & Mackay, 1990). According to the transmission deficit model, proper names (such as Mr Baker) are more susceptible to retrieval failures than role descriptions (the baker).

It has been found that older adults have particular difficulty with memory for proper names (e.g., Cohen & Faulkner, 1984, 1986; James, 2004; Fogler & James, 2008). Cohen and Faulkner (1986) found that while names were harder to learn than other types of information for older adults, there were no age-related deficits for learning names. Barresi, Obler and Goodglass (1998) presented both young and older adults pictures of men's faces (which had been paired with a name and an occupation) and their task was to learn the name and occupation that goes with the right picture. They found that older adults displayed a specific age-related deficit in learning proper names rather than roles. James (2006) asked younger and older adults to name familiar famous people and provide their occupations. Participants had greater difficulty producing names rather than their occupations and the retrieval failures were greater in the older age group.

Neurological Correlates in the Ageing Brain

Since the 1990s, there has been a revolution in the field of neuroscience that has lead to converging evidence on the neural and cognitive changes of aging. A study

using fMRI examined the patterns of young and older adults' BOLD responses in a stroop task (Milham, Erickson, Banich, Kramer, Webb, Wszalek, & Cohen 2002). They found that areas in the brain associated with attentional selection (dorsolateral prefrontal cortex and parietal cortex) were less active and areas associated with verbal processing (temporal cortex) and conflict detection (anterior cingulate) were more active and attentional selectivity was reduced with old age therefore leading to increased load for processing colour and word information.

According to the frontal lobe hypothesis there is differential decline in old age of neurons in the frontal lobe, and cognitive functions supported by these areas are more susceptible to age effects (e.g., West, 1996; Hartley, 1993; Van der Molen & Ridderinkhof, 1998). Anderson and Craik (2000) proposed that the age-related neuronal loss occurring in the frontal lobes with increasing age mediates general cognitive changes. However changes also occur in the rest of the frontal cortex, such as the temporal and parietal cortex (e.g., Greenword, 2000). There is no direct link between changes in the frontal lobe and changes in performance. Rabbitt and his colleagues argue that a number of methodological flaws in some studies have lead to false support for the frontal lobe hypothesis (e.g., Rabbitt, Lowe, & Shilling, 2001).

Recent research has highlighted that decreases in the number of dopamine receptors in the basal ganglia, the pre-frontal cortex and the anterior cingulated can indirectly account for a number of behavioural age effects (e.g., Bäckman, Ginovart, Dixon, Robins Wahlin, Wahlin, Halldin, & Farde, 2000; Braver & Barch, 2002; Li, Lindenberger, & Sikstro, 2001). In a study by Li et al. (2001) they demonstrated the loss

dopaminergic support could explain age effects on the functional limitations of working memory and inhibitory control.

Attention

There is an association between aging and declines in cognitive processing, especially in mechanisms either general or specific that weigh on attentional resources (e.g. Verhaegen, Marcoen & Goosens, 1993). Craik (1983; Craik & Byrd, 1982) argues that attention demanding or cognitively effortful tasks (such as attention switching or dual-task) will be performed less efficiently with increasing age due to decreased attentional reserves. Dual-tasks involve carrying out more than one task at the same time in order to see how effectively the tasks can be carried out before attentional reserves are depleted (e.g., Kerr, 1973). The difference in performance levels between young and older adults have been attributed to decreases in attentional capacity with age (e.g., Burke & Light, 1981; Craik & McDowd, 1987; Hasher & Zacks, 1988).

Maule and Sanford (1980) monitored participants' ability to observe three information sources each described as controls of an oven cooking a particular product. They were required to 'reset' the cooking cycle by pressing the 'look' button to check if the cooking stages had been competed in order to minimise the amount of time any oven was out of action due to the cooking process being completed. However, participants could only check one source at a time. Maule and Sanford varied the frequency of the three different sources, with the cooking processing being completed faster in source A whereas sources B and C were less frequent. Both age groups made relatively longer

observations to sources which were more likely to occur, but this occurred to a greater

extent in the young. The results showed that older adults were less selective because of a

greater tendency to observe the relatively infrequent sources B and C.

Sensory/perceptual deficits

Sensory deficits in visual as well as auditory acuity have a direct impact on

subsequent linguistic processes (e.g., Brown & Pichora-Fuller, 2000; Pichora-Fuller &

Singh, 2006; Schneider & Pichora-fuller, 2000). Older adults tend to have reduced visual

acuity, and suffer from a range of conditions that limit a person's vision, such as

presbyopia (the thickening and hardening of the lens that make it harder to focus),

cataracts and glaucoma (e.g., Baltes & Lindenberger 1997).

Two forms of hearing loss are also quite common in later life, Presbycusis

(otherwise known as sensorineural hearing), where degenerative changes occur in the

cochlea or auditory nerve and conductive hearing loss, where damage occurs in one of

the structures (e.g., the ear drum/ tympanic membrane) that transmit sound within the ear

(Schneider & Pichora-fuller, 2000). For example, by presenting words in visual noise or

with asterisks between letters has a larger impact on older adults compared to younger

adults and this pattern of results has been shown for auditory language processing in

noise (e.g., Schneider & Pichora-fuller, 2000). Baltes and Lindenberger (1997) reported

a 20-fold decrease in the age-related variance when auditory and visual acuity was

controlled for.

General slowing theories

Proponents of general slowing theories argue that some cognitive operations may be executed too slowly in order to be successfully completed in the time available (e.g., Salthouse, 1992; 1996). It has been well-documented that processing abilities slow down with age (Myerson, Hale, Wagstaff, Poon, & Smith, 1990; Salthouse, 1982) and when a task involves speed the consequence is that older adults will fare less well. Some have argued that the rate of age-related slowing is the same for all cognitive operations (e.g., Cerella, 1985) or that age-related variance in speed should not be expected to be of the same magnitude (e.g., Salthouse, 1992; 1996; 2000; Lima, Hale & Myerson, 1991).

The slower processing speeds to perform critical operations such as encoding, retrieval and integration is not assumed to be the exclusive source of age-related variance, because other age-related deficits also exist (Salthouse, 1996). It has been claimed that age-related decreases in speed is one of the major causes of the variations in working memory with increasing age (e.g., Salthouse, 1992). The general slowing model has been used as a way to explain older adults' greater difficulty in comprehending speeded speech (e.g., Wingfield, 1996).

Working memory

The fact that working memory plays a crucial role in reading comprehension has been well-documented (for a review, see Daneman & Merikle, 1996) as well as the fact that working memory capacity declines with ageing (for meta-analysis, see Verhaegen et

al., 1993; Engle, Tuholski, Laughlin, & Conway, 1990). Numerous studies have shown older adults with smaller working memory spans have reduced sentence comprehension and text memory compared to younger adults (e.g., Tun, Wingfield, Stine, & Mecsas, 1991).

Under the working memory model, older adults' capacity may be taxed more heavily during sentence comprehension compared to younger adults (e.g., Burke & Shafto, 2008). There is finite pool of working memory resources shared by different mental processes that can occur at the same time or shortly afterwards (e.g., Kahneman, 1973). Therefore, in some circumstances, there will not be enough resources to complete all the processes necessary for accurate performance (e.g., Rabbitt, 1968). As older adults have reduced working memory capacity, they reach the point were their resources are exhausted more quickly compared with younger adults (e.g., Craik & Byrd, 1982; Just & Carpenter, 1992).

Caplan and his colleagues argue that there is not a relationship between on-line syntactic processing and traditional measures of working memory (Caplan & Waters; 1999; Waters & Caplan; 1996; 2001). They argue that rather than a single-resource theory, which explains the relationship between working memory and language processing, a separate-sentence-interpretation resource theory is needed. Therefore, online interpretative processes such as resolving the syntactic structures and meanings of sentences is largely unconscious and as a result of this should be resistant to aging. In contrast, off-line post-interpretive processes such as plausibility judgements and sentence recall relates instead to traditional working memory measures and should be sensitive to age (Waters & Caplan, 2001). A recent study by DeDe, Caplan, Kemtes & Waters

(2004) using structured equation modelling found that verbal working memory measures did mediate age-related differences in off-line comprehension tasks, but did not predict performance on on-line listening measures. The exact nature of how working memory modulates age-related changes in language processing remains unclear, however, the fact working memory plays an important role is clear.

Inhibition

According to Hasher & Zacks (1988), changes in inhibitory processing are central to age-related changes in cognitive functioning. Inhibition exerts control over the context of working memory by filtering out irrelevant or no longer relevant stimuli from exhausting working memory capacity (e.g., Hasher & Zacks, 1988; Hartman & Hasher, 1991). The inhibition deficit theory proposes that ageing weakens the ability to selectively regulate attention affecting a broad range of discourse comprehension.

A study by Hamm and Hasher (1992) investigated if there were any age differences in inference availability and memory using a speeded decision and cued recall tasks. No age differences were found when the text was consistent with the most appropriate interpretation (e.g., that a hunter on a photographic safari would be taking a shot with a camera). However, when the text was deliberately inconsistent (e.g., to believe that the safari would be taking a shot with a gun), older adults were more impaired in their ability to recall the final, correct interpretation (a camera). They claimed that older adults were likely to sustain more alternative interpretations and show

a far stronger tendency to agree with the other competing interpretations compared to their younger counterparts.

The failure to inhibit irrelevant information has also been shown in the garden-path sentence task developed by Hartman and Hasher (1991). Participants were presented with sentence fragments and instructed to think of a highly probable word before providing them with a less probable word to complete the sentence. They were informed that they had to remember the less probable word in a subsequent memory test. However, older adults were more likely recall the more probable word rather than less probable word compared to younger adults.

A related study by Connelly, Hasher and Zacks (1991) presented readers with passages of text containing distracter words in different typefaces and when asked to read the texts aloud, older adults read more slowly compared to younger adults. They claimed that older adults were not able to ignore the distracting material, which lead to their slower reading speeds.

These findings suggest that older adults hold more alternative interpretations compared to younger adults. The age-related deficits in inhibitory mechanisms may permit a broader range of activation and this has a detrimental affect on older adults' ability to filter out irrelevant information.

Language Comprehension in Older Adults

According to Zwaan and Radvansky (1998), readers construct a surface representation of the content (the textbase), and a more global representation of what the

text is about, called the *situation model*. They claim older readers place greater attention to discourse features, what they refer to as 'the situation model' compared to younger adults (Radvansky, Zwaan, Curiel & Copeland, 2001; Radvansky, Zacks & Hasher, 2005; Radvansky, Copeland & Zwaan, 2003; Glenberg, Meyer & Lindem, 1987; Graesser, Millis & Zwaan, 1997; Zwaan & Radvansky, 1998). This could perhaps explain why language skills are relatively resistant to decline.

Processes involving drawing inferences (such as anaphora) appear to be well preserved in old age unless working memory is taxed or if information must be actively retrieved over delays (Cohen, 1979; Light & Albertson, 1980; Light & Capps, 1986; Light, Capps, Singh, & Albertson Owens, 1994; Zelinski, 1988). Morrow, Leirer and Altieri (1992) presented participants' with a narrative containing critical sentences which either referred to a main protagonists or minor character (See the examples below). They then measured the time it took participants' to read a target sentence and the ability to identify the referent character correctly. The final target sentence was either preceded by the protagonist or minor character in order to measure whether protagonist and recency cues help readers choose the correct referent.

This was Peter's first year as a flight engineer, and he was already looking forward to advancing. If I do real well, I'll soon be first officer, and then captain," he thought. Today he sat in the third seat of the 727, poring over the maintenance logbook. Next he started the panel preparation checklist. He set the fuel crossfeed selectors and checked the electrical power switches. When the captain entered the cockpit he nodded and returned to his checklist. He always

tried to be industrious when the captain was around. While the captain was

talking with the first officer, he thought about his previous job.

Protagonist Critical sentence: Peter used to work for a commuter company that always

seemed about to fold. He was glad to be out of that job, although he missed the hands-

on-flying.

Minor Character Critical sentence: The captain ordered the first officer to check the radio

and transponders. He checked the autopilot and made sure it was off.

Protagonist (recent or distant) target sentence: Now he looked forward to when he could

be behind the yoke again.

Minor Character (recent or distant) target sentence: He made sure that everyone in the

cockpit was busy doing their job.

Morrow et al. found that participants would process target sentences referring to

minor and distant characters more slowly and less accurately compared to the main

protagonist and recent characters. There was also an age difference in referent choice for

pronouns referring to minor and distant characters. They claimed older adults' had

greater difficulty reinstating the intended referent due to reduced working memory

capacity.

A related study by Valencia-Laver and Light (2000) investigated older adults' ability to generate causal bridging inferences. They tested participants' ability to recognise a target word which was either explicitly or implicitly mentioned compared to a control target word. In order to correctly comprehend a passage, it is sometimes necessary to generate a causal bridging link between two propositions (see examples below).

The angry swarm of bees flew out of the hive, landed on Joan's hand and began to sting. Her hand was soon very sore and she regretted having bothered the insects (Explicit).

The angry swarm of bees flew out of the hive and landed on Joan's hand. Her hand was soon very sore and she regretted having bothered the insects (Implicit).

Target: Sting

Control: Baked

The results showed that participants were able to draw causal bridging inferences while reading, more so in the explicit condition. The results also showed that older adults were equally able to generate causal bridging inferences as readily as younger adults. This contradicts previous findings by Cohen (1979) which showed an age-related deficit in the ability to generate a causal bridging link. However, this study used delayed rather than immediate measures.

Studies on metaphor processing have indicated that older adults perform equally well as younger adults in understanding metaphors and their ability to do so remains largely intact (Light et al., 1994). In a study by Newsome & Glucksberg (2002) they found that although older adults were generally slower than the younger adults, they still displayed the same trends. For both groups, after they read the metaphors they were faster at verifying metaphor-relevant information (Sharks are tenacious) after a metaphor prime (The lawyer for the defence is a shark) compare to a literal control prime (The large hammerhead is a shark), whereas metaphor-irrelevant properties (Sharks are good swimmers) were responded to slower after metaphor primes. The results indicate older adults (like younger adults) are able to enhance relevant metaphor information and filter out irrelevant metaphor information during metaphor comprehension.

In a related study Humphrey, Kemper and Radel (2004) investigated older adults' figurative language processing to see if older adults have difficulties in interpreting metonymies, processing times should be longer. A metonym can refer to a term like *Vietnam* which can be used to refer to the war or the country depending on the context. The study also aimed to replicate the figurative language processing results found by Frisson and Pickering (1999) with younger adults using materials like:

1.1 The representatives negotiated with the prison/statue to make their point a bit clearer. (Literal familiar/unfamiliar control)

1.2 This morning the terrorists blew up the prison/statue in order to gain publicity for their cause. (Familiar/unfamiliar metonymies)

Based on the total reading times, unfamiliar metonymies (statue) were read more slowly than familiar metonymies (prison) and more slowly than their literal controls, thereby replicating Frisson & Pickering main findings. It is important to note that the reading times were similar for both older and younger adults.

There is also evidence to suggest that both young and older adults routinely comprehend the implied shape of entities. Dijkstra, Yaxley, Madden and Zwaan (2004) presented participants with sentences (such as *the ranger saw an eagle in the nest/sky*), followed by a line drawing of an object (e.g., an eagle with its wings folded (a) or outstretched (b).

(a)   (b)
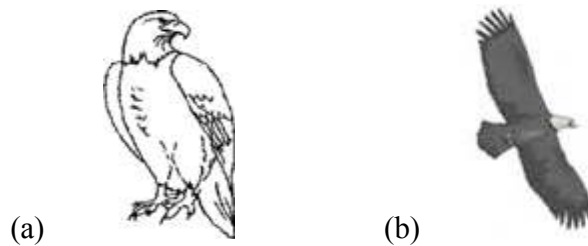
Figure 1.2: Example images used by Dijkstra, Yaxley, Madden and Zwaan (2004).

If the features of the drawings mismatched the implied features from the sentence, participants were slower to respond whether the pictured object had been mentioned in the sentence. For example, when participants read a sentence about an eagle in a nest, they responded more slowly when they were shown a picture of an eagle with outstretched rather than folded wings. Older adults showed a larger mismatch effect compared to younger adults, suggesting the violation of the implied features of the object made more of an impact. It would seem the ability to use perceptual information in sentence comprehension is well preserved in healthy ageing.

The use of eye-tracking methodology has shown older adults' are able to use frequency and predictability information to guide subsequent processing (see chapter 2 for a fuller description of eye-tracking). Rayner, Reichle, Stroud, Williams and Pollatsek investigated if there were any age differences in the effects of word frequency, word predictability and font difficulty on eye movements (see examples below).

High frequency/low predictability/Times New Roman font

I took a tour of a famous building while I was on holiday.

High frequency/low predictability/Old English font

I took a tour of a famous building while I was on holiday.

Low frequency/high predictability/Times New Roman font

I took a tour of a famous catacomb while I was on holiday.

Low frequency/high predictability/Old English font

I took a tour of a famous catacomb while I was on holiday.

High frequency/high predictability/Times New Roman font

The police closed off the dangerous building yesterday.

High frequency/high predictability/Old English font

The police closed off the dangerous building yesterday.

Low frequency/low predictability/Times New Roman font

The police closed off the dangerous catacomb yesterday.

Low frequency/low predictability/Old English font

𝔗𝔥𝔢 𝔭𝔬𝔩𝔦𝔠𝔢 𝔠𝔩𝔬𝔰𝔢𝔡 𝔬𝔣𝔣 𝔱𝔥𝔢 𝔡𝔞𝔫𝔤𝔢𝔯𝔬𝔲𝔰 𝔠𝔞𝔱𝔞𝔠𝔬𝔪𝔟 𝔶𝔢𝔰𝔱𝔢𝔯𝔡𝔞𝔶.

There were clear affects of word frequency, word predictability and font difficulty in the eye movement patterns for both young and older adults. Both young and older had longer fixations when the font was more difficult to read. Older adults had overall longer fixations times compared to younger adults but the pattern of results were similar. Participants had longer fixations to low frequency words compared to high frequency words and the effect of frequency was much larger in the older age group. Older adults were also more likely to skip high frequency words than low frequency words but this pattern was not found with younger adults.

They were also more likely to regress back to skipped words which Rayner et al. suggested older readers adopted a more risky reading strategy. Consistent with the frequency effects, participants had longer fixations in the less predictable conditions compared to high predictability but the effect of predictability was similar for both age groups. Older readers were also more like to skip the target words but unlike the previous findings, there was no difference in regressions compared to younger adults.

A related study by Kliegl, Grabner, Rolfs and Engbert (2004) also found that older adults' eye fixations were longer than those of younger adults. They claimed the similarity between older and younger readers was more interesting than the lack of differences.

The use of ERP methodology has shown older adults' are able to use context to guide subsequent processing (Kemner, Coulson, DeOchoa & Kutas, 2004). Event-related

brain potentials (ERP) methodology provides an online record (in the order of milliseconds) of the brain's electrical activity detectable at the scalp, revealing important information about the neural processing immediately after a stimulus (e.g., Kutas, Federmeier, Coulson, King & Muente, 2000; Kemner et al., 2004). The assumption is that cognitive sub-processes are modulated by different anatomical and physiological substrates and as such they will generate distinct patterns of neuronal activity.

ERP waveform generally consists of a series of positive and negative deflections, commonly referred to as *components*. ERP components can be classified according to various characteristics of the waveform, particularly their *polarity*, which can be positive or negative, their *latency*, and their *scalp distribution* (or topography). Generally, components occurring before 200ms are thought to reflect late sensory and early perceptual processes, whereas those occurring after 250ms are thought to reflect higher level cognitive processes, such as memory or language.

A study by Federmeier and Kutas (2005) investigated whether healthy older adults would be able to use constraining sentence-level information as quickly and accurately as younger adults.

1.3 The cold drink was served with a slice of <u>lemon.</u>

1.4 The only food left in the barren refrigerator was a mouldy <u>lemon</u>.

A reduced N400 constraint effect was evident in the older group, which was larger over centroparietal sites compared to younger adults. A related study by Federmeier, Mclennan, DeOchoa and Kutas (2002) found that the ERP responses to

highly predictable words (tulips) versus unexpected words (pines) were similar for both age groups suggesting that they were able to use contextual information to the same degree.

        1.5.   The tourist in Holland stared in awe at the rows and rows of colour. She wished she lived in a country where they grew tulips/roses/pines.

However, while younger adults produced intermediate ERP responses to the similar word (roses) suggesting that they were able to use context in a fine grained way, older adults did not differ between the two less predictable words (roses vs. pines). Federmier et al. claimed older adults are able to use context to some extent but not to the same extent as younger adults do.

<u>Evidence of Shallow Language Processing in Older Adults</u>

It has been commonly assumed that language processing is essentially as complete as possible; however, recent evidence suggests that it is in fact far from uniform. Emerging research now suggests that processing can be quite shallow (e.g., Ferreira, Ferraro, & Bailey, 2002; Sanford & Sturt, 2002; Sanford & Graesser, 2006; see chapter 2 a fuller review). Therefore, it could be suggested that older participants construct more shallow representations and rely on good enough representations more frequently, compared to younger participants (Christiansen, Williams, Zacks & Ferrieria, 2006).

A recent eye-tracking study by Daneman, Hannon & Burton (2006) used Barton & Sanford's (1993) anomaly detection task to investigate whether the aging process influences a reader's ability to spot it. Barton and Sanford (1993) investigated factors influencing the probability of participants detecting an anomalous word, spontaneously, in a description of a situation. Participants in this study were asked to read the following passage (1.6) and then answer the following question.

1.6   There was a tourist flight from Vienna to Barcelona. On the last leg of the journey, it developed engine trouble. Over the Pyrenees, the pilot started to lose control. The plane eventually crashed right on the border. Wreckage was equally strewn in France and Spain. The authorities were trying to decide where to bury the survivors.

QUESTION: What is your solution to the problem?

Barton and Sanford (1993) found that in the basic version of this problem only 60% of participants recognized that you should not bury survivors as they are in fact still alive, they failed to process the full meaning of the word *survivor*.
In order to generalize the results to a wider set of anomalous terms and texts, Daneman et al. used four new passages which were based around Barton and Sanford's survivor problem (see 1.7 below).

1.7   Once again Amanda was studying all night for exams. She entered the

school and picked up her third extra large coffee. After drinking her black

coffee she went into the library. But when she sat down, she found that

she could not focus. She was so hyperactive that she couldn't even sit

still. Amanda was bouncing all over because she had taken too many

tranquilizing sedatives/ tranquilizing stimulants/ potent stimulants.

The internally coherent anomalous noun phrases (tranquilizing sedatives) were easier to detect than the internally incoherent anomalous noun phrase (tranquilizing stimulants). However, they found no age differences between younger and older adults' abilities to detect an anomaly. However, differences did emerge in the eye-tracking data; older detectors also appeared to notice the easier to detect internally coherent anomalous noun phrases sooner than their younger counterparts. Older adults seemed to allocate more processing resources towards regressive eye-movements to the internally incoherent anomalous noun phrase relative to the non-anomalous noun phrase (potent stimulants) than their younger counterparts. Daneman et al. claim that these findings suggest older adults allocated more resources to anomaly detection and recovery compared to younger adults.

There is evidence to suggest that older adults allocate resources differently depending on the task demands compared to younger adults. Brebion (experiment 2, 2003) revealed specific age-related impairments in a sentence processing/word storage trade-off. Participants were instructed to make sentence acceptability judgements as well

as recalling increasing word memory loads. The sentences varied in syntactic complexity and examples are given below.

1.8   Tales lead us to imaginary (inflatable) lands where animals talk to

children.   (Easy)

1.9   I used to believe that the storks I saw flying by brought babies (bike) to

families.   (Medium)

1.10   The silence of these places attracted all, who like me, were looking for a

rest (rake).   (Difficult)

When a four word load had to be kept in memory, word recall was affected by sentence processing difficulty in older adults; and sentence verification was given more priority. The younger adults seemed to invest effort into holding the word load when simultaneously processing the sentences. Whereas for older adults, when the word load consisted of six words, seemed to devote their resources to sentence processing. This resulted in older adults seemingly less affected by the increases in load (Brebion, 2003).

When the resource capacity is overtaxed, competition occurs between processing and storage leading to a trade-off between the two. The older participants devoted most of their resources on the sentence processing task; so therefore fewer resources are left for the previously processed word load. It was claimed that 'new' information may be given priority to the detriment of 'old' information previously encoded, and the competition between the two might impair coherence in discourse processing (e.g., Brebion, 2003; Just & Carpenter, 1992).

Recent evidence from investigations of garden-path sentences also support the idea that the meaning younger and older adults obtain for a sentence is often not a reflection of its true content (Christianson et al., 2006). There is evidence to suggest that older adults display greater difficulty answering comprehension questions about ambiguous garden-path type sentences (Kemtes & Kemper, 1997).

Christianson et al., (2001) presented participants with sentences (containing optionally transitive verbs) (1.11); they initially took "the baby" to be the object of "dressed." In sentence (1.12), it contains a reflexive absolute transitive verb, which participants initially took 'hunted' to mean the hunters were chasing the deer. Moreover, incorrect interpretations persisted even after syntactic reanalysis had taken place (Christianson *et al.*, 2001).

1.11 While Anna *dressed* the baby that was small and cute played in the crib. (*Reflexive absolute transitive verb*, subordinate-main clause order)

1.12 While the man **hunted** the deer that was brown and graceful ran into the woods. (**Optionally transitive verb**, subordinate clause order)

They found very little evidence of age-related differences; however, older adults were more likely to endorse the reflexive verb than were younger adults. The results are consistent with the idea that participants at each age level do not necessarily fully resolve syntactic ambiguities of garden-path sentences.

IMPLICATIONS

The declines in processing resources over the years and how this affects language processing has been well documented (e.g., Craik, 1983; Hasher & Zacks, 1988; Carpenter et al., 1994; Salthouse, 1996). There is evidence to suggest older adults allocate resources differently compared to younger adults to compensate for the decreases in cognitive capacity in order to offset difficulties in processing complex sentences (Brebion, 2003). Older adults show relatively better performance when tasks are self-paced rather than experimenter-paced and may even be absent when the memory load is not high (Johnson, 2003, Light & Albertson, 1988).

When older adults have a vocabulary advantage over the young, the age differential was smaller and differences in performance were also smaller when older adults had superior intellectual ability (Johnson, 2003). If older adults are allowed to compensate for declines in mental mechanics by reading at a slower pace (Johnson, 2003) and adopting a more cautious criterion (Brebion, 2003), age-related changes are less evident. Within this brief overview of the ageing literature, I have focused only on studies that have shown equivalent or better performance in the older age group.

Focus and other 'attention capturing' devices place emphasis on the most important piece of information the writer or speaker is trying to convey. Thus, placing a concept in focus should ease age-related deficits in inhibitory mechanisms as there is evidence to suggest older adults are less able to filter out irrelevant information (e.g., Connelly et al., 1991; Hartman & Hasher, 1991; Hamm & Hasher, 1992).[1] Since

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[1] In the course of this thesis I will use the more general cognitive mechanisms of enhancement and suppression rather than inhibition (see the next chapter for a fuller explanation of these terms).

selective attention is compromised in this way, a decline in the effectiveness of focus cues for selective processing with age might be expected instead. However, older adults appear to show equivalent performance to younger adults' in some aspects of language comprehension, and this would indicate that focus cues will prove to be a valuable tool for older adults to use.

Although older adults demonstrate deficits in a variety of areas, several studies have clearly shown that there are only very minor age differences in language processing. As far as I am aware, there is no existing work on whether older people are more likely to use focus cues to the same or to a greater extent as younger adults, or whether they are likely to show a deficit in cue utilisation. In light of this, I aim to establish whether focus (or other emphasis methods) plays a greater (or lesser) role in modulating language processing in older adults than it does in the young.

CHAPTER 2: GENERAL INTRODUCTION TO LINGUISTIC FOCUS AND RELATED PHENOMENA

BASIC ASPECTS OF FOCUS

The term "focus" has been used in linguistics and psychology by various researchers to describe related phenomena. Focus can be defined as those parts of a sentence or an utterance that contribute the most salient piece of information. This can be achieved either through prosody or syntactic devices, and, depending on the language, it can include both (e.g., Chomsky, 1971; Halliday, 1967).

In the course of this thesis, I will use the term 'focus' in a manner taken from the field of semantics where focus is defined in terms of contrasting sets of alternative interpretations (e.g., Rooth, 1992). It allows a speaker or writer to indicate what they want a listener or reader to pay attention to.

One focusing technique is cleft or pseudo-cleft sentence constructions (e.g., Kiss, 1998). Cleft sentences usually begin with the word *it*, followed by the element to be focused and the rest of the statement, whereas a pseudo-cleft sentence contains a wh-cleft on the subject or complement, for example:

2.1.   It was Joseph who bought the side table. (Emphasis on Joseph)

2.2.   What Joseph bought was the side table. (Emphasis on the side table)

2.3.   Joseph bought a side table. (No emphasis on Joseph or the side table)

In sentence (2.1) the implicit question in it answers is, "*Who bought the side table*?" It is thus natural to process the sentence with a narrow focus on the first noun phrase (NP1), *Joseph*, as it identifies a certain person from a set of implicit alternatives,

providing an implicit answer to the implicit question in the sentence. In sentence (2.2) the implicit question in its structure is, "*what did Joseph buy*?" So, it is natural to process the sentence with a narrow focus on the second noun phrase (NP2), *the side table*, as it identifies a certain object from a set of implicit alternatives, leading to an answer to the implicit question in the sentence. When compared to sentence (2.3) it has a broad focus on the proposition expressed by the whole sentence.

Focus Facilitates Processing

There has been a great deal of research examining how focus devices facilitate pronominal reference. Pronouns are common in everyday language and the referent of an anaphoric pronoun is usually determined by the comprehender without any conscious effort or difficulty (e.g., Shillcock, 1982). When a reader or listener encounters a pronoun, it typically refers to the most salient referent in the discourse, however, if it turns out to refer to a different entity it can lead to disruption in processing (e.g., Gordon, Grosz & Gilliom, 1993). Anaphors which require more extensive processing are thought to tax limited working memory resources; however, placing the most salient features in focus minimises integration costs (e.g., Almor, 1999).

In a corpus study by Arnold (1998) demonstrating the selective function of focus, clefted elements were referred to more often than other referents contained within the same sentence. When participants were asked to rate the naturalness of three-sentence paragraphs, when a cleft construction was used in the second sentence, the paragraphs were rated higher when the focused element was subsequently referred to by a pronoun.

One of the earliest studies of focus effects was by Hornby (1974). Participants' listened to either cleft or pseudo-cleft sentences that placed either the agent or the object into focus. They were then presented with a simple picture depicting an actor performing a specific action on an object which they had to verify if it corresponded with the previous sentence.

2.4   It was the girl that is petting the cat.

2.5   The one that is petting the cat is the girl.

Participants were instructed to respond either 'true' if the picture accurately depicted the sentence they had just heard or respond 'false' if they noticed an error between the picture and the corresponding sentence. Of the pictures presented, some of them contained erroneous information, for example, a boy instead of a girl, a dog instead of a cat. Participants tended to make more errors when the picture showed a boy after sentence 2.5 and when the picture showed a dog after sentence 2.4.

Embedded questions can also be used to place emphasis on certain parts of a sentence by manipulating the prior context by presenting either sentence 2.6 or 2.7 before the target sentence 2.8. In a phoneme monitoring task, phoneme detection was faster for the /b/ in *blue* when the emphasis was on the hat in 2.7, compared to when the focus was placed *on the corner* in 2.6.

2.6   Which man was wearing the hat? (Emphasis on the man)

2.7   Which hat was the man wearing? (Emphasis on the hat)

2.8   The man on the corner was wearing the blue hat.

Listeners were able to detect target phonemes faster when they were part of the focused phrase. On the basis of these results, Cutler and Fodor (1979) suggested focus accelerated sentence comprehension processes; material in focus is verified more quickly and accurately.

Sentence Stress and Pitch Accents

Sentence prosody can influence the way in which word meanings are integrated into the overall meaning of an utterance. It allows a listener to attend to a particular concept, so that he or she pays more attention to the focused part rather than processing the non-focused parts (e.g., Hornby, 1974). The changing pattern of stress within a sentence is referred to as sentence stress, where stress is typically placed on certain words to which we want to draw attention too (MacMahon, 1997). For instance:

I would like a STRONG[2] coffee.

Listeners often perceive a stressed word to be louder, higher in pitch, longer in duration and pronounced with fuller vowels or syllables compared to surrounding words (e.g., Birch & Clifton, 2002). Listeners are sensitive to stress and pitch accent patterns of an utterance. A word that is pitch accented is a type of emphasis given to a spoken word or syllable (Crystal, 1995). Pitch accent, unlike sentence stress, does not necessarily

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[2] The emphasised word has been capitalised in this example.

mean a word is spoken louder or longer in duration. Usually, pitch accent is more marked than others within the intonation contour.
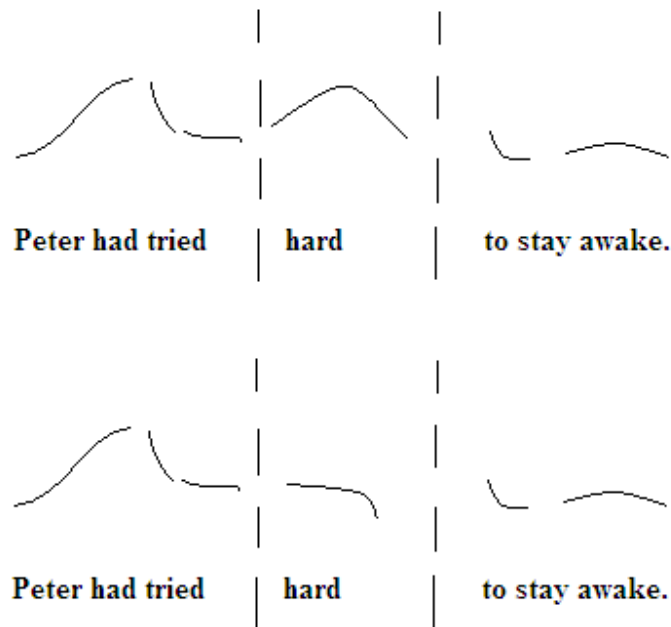
Figure 2.1 Illustrative pitch track contours (changes in the fundamental frequency, F0).

In the top illustration, the pitch accent on the word *hard* rises sharply before falling, forming what Ladd (1980; 1996) has described as the 'hat' shaped pitch contour. Note also that the duration of the critical word is longer, a typical indication of emphasis being added to a word. Whereas in the bottom illustration on the contour of the word *hard* is relatively flat. In Pierrehumbert's (1980) system of notation, the L+H* pattern (a low pitch rising to a high pitch, the asterisk indicating that the high pitch is aligned with the stressed syllable of the word) would give the pitch accent the classic 'hat' shape Ladd describes.

Birch and Clifton (1995) examined sentences with different patterns of pitch accent and found that judgments of prosodic appropriateness was higher when 'new'

noun phrases were accented and 'old' noun phrases were not. This suggests that placing emphasis through pitch accents on a word is more readily detected than an unaccented word (e.g., Cutler & Foss, 1977).

RELATED 'ATTENTION CAPTURING' DEVICES

Main – Subordinate clauses

In psychology, focus has been used to describe linguistic elements that are brought to the forefront of processing. Existing evidence suggests that main clauses of complex sentence are given more prominence in subsequent processing than are subordinate clauses (e.g., Cooreman & Sanford, 1996). Consider:

2.9   When John got back home from the pub, Mary served dinner.

'Mary serving dinner' refers to 'new' information that has been just introduced; compared to 'given' information of 'John returning home', what Garnham (2001) calls presupposed information. According to Halliday (1967), every sentence contains information the speaker or writer assumes that the listener or reader already knows (given), or presupposes, and some new information. In constructions like 2.9, the given information is in the subordinate clause, while the new information is in the main clause. This in turn makes the main clause more prominent.

Cooreman and Sanford (1996) found that participants were more likely to produce sentences referring to the main clause (e.g., Mary serving dinner) rather than the

subordinate clause (e.g., John returning home) of the sentence in a sentence continuation task. They also found that referring to information contained in the main clause led to faster self-paced reading times for anaphoric sentences compared to the subordinate clause. In a related study by Baker and Wagner (1987, discussed in greater detail in next section) participants were less likely to notice false information when the sentence structure signalled that the information was subordinate rather than of central importance. Thus, there is clear evidence that main clauses give rise to facilitated processing when compared with subordinate clauses (e.g., Baker & Wagner, 1987; Cooreman & Sanford, 1996). However, there are also findings to suggest the order in which the two characters appear has a major impact, and this appears contrary to the facilitation of main clauses just described.

Gernsbacher, Hargreaves and Beeman (1988) used a probe recognition task to test participants' recognition levels for first versus second mentioned characters with various sentence types, including main-subordinate constructions. When tested immediately the greatest access is given to the clause currently being processed (i.e., the final clause). However, with a delay of 1400 milliseconds, participants mentioned first in a sentence are more available than participants mentioned second (e.g., Gernsbacher & Hargreaves, 1988; 1992; Gernsbacher, Hargreaves & Beeman, 1989). These studies contradict another set of studies also using a probe recognition that demonstrated the second-mentioned advantage (e.g., Caplan, 1972; Chang, 1980; Von Eckhardt & Potter, 1983).

According to Gernsbacher's (1990) structure building framework, the first-mentioned advantage arises because they form the foundations of the sentence-level representation in which subsequent information is mapped onto the framework. The

advantage of the most recent clause arises because they have the greatest access to the information represented in the substructure they are currently developing.

The dimensional distinctiveness model of Neath (1993) could account for the differences between first and second mentioned participants in sentence processing (E.g., Gernsbacher, Hargreaves & Beeman, 1989). Neath presented four item lists containing photographs of snowflakes with a constant inter-item presentation interval (IPI) of one second but a retention interval (RI) of between zero and ten seconds. With short RIs, performance was poorest for the initial items and better for the final items, as the RIs increased, performance was best for the initial items. So if the model is capturing the fundamental characteristics of memory, this could account for the change from second-mentioned advantage to the first-mentioned advantage.

Neath and Knoedler (1994) presented similar materials to Gernsbacher et al (1989) at one word at a time, as if they were items in a list so there was clear, measurable IPIs and RIs. The change from second-mentioned advantage to first-mentioned advantage with increasing RIs, appeared to be identical to the pattern of the shift from recency to primacy effects with larger RIs. They found that second-mentioned characters were more distinctive with shorter RIs, whereas when the RIs increased, the first character becomes more distinctive than the second. Thus, the dimensional distinctiveness model suggests that factors affecting primacy and recency in a traditional memory experiment can explain the findings by Gernbacher and her colleagues (e.g., Gernsbacher & Hargreaves, 1988; 1992; Gernsbacher et al., 1989). Therefore, Gernsbacher and her colleagues' findings are capturing memory processes rather than differential processing of first and second mentioned characters due to linguistic factors.

However, the issue is far from settled, and throughout this thesis, data relevant to the purported first-mention advantage are presented.

Name/role Distinction

It has been shown that aspects of the status of characters lead to focus-like effects in discourse. Specifically, in short texts, main characters appear to be more prominent than secondary characters and facilitate pronominal resolution (Anderson, Sanford & Garrod, 1983; Morrow, 1985). Often in character-based narratives and stories, there is more than one character mentioned in the discourse (Sanford, Moar & Garrod, 1988). However, not all characters are given equal importance at the same time in the discourse. Some are seen more as main characters, while others are given a lesser status. For instance, one character may be viewed as the principal agent while other characters in the discourse may be viewed as performing a more limited role.

Anderson, Garrod and Sanford (1983), using a sentence continuation task, found that participants made more references to main characters than to secondary characters. Main characters tend to be introduced earlier than secondary characters and more often than not are given a proper name (e.g., Paul, Mrs Gibson etc.) whereas a secondary character is more likely to be referred to by a role description (e.g., Doctor, Waitress etc.), and this was the case in the Anderson et al. studies.

There is direct evidence to show that named characters are more likely to be referred to in a sentence continuation task and therefore more prominent than characters described by a role. In a study by Sanford, Moar & Garrod (1988) a sentence continuation task was used to explore the impact of potential cues such as order of

mention, scenario-dependence and type of description used (proper name vs. role). They found that it was only the type of description (a proper name) that influenced the subject of the continuation sentence. They also found in a self-paced reading task that named characters lead to reduced processing times for sentences containing anaphoric references than when a character was described by a role, thereby corroborating the sentence continuation findings.

PSYCHOLOGICAL STUDIES AND THEORIES

Focus and the shallow-processing hypothesis

Recent work on discourse processing has highlighted growing evidence that discourse representation is not always complete (Ferreira *et al*., 2002), and it has been suggested that representations of text are often 'underspecified' (Sanford & Sturt, 2002). In a review by Ferreira *et al*., (2002) the claim is made that language input is represented at a degree of specification that is sufficient for the situation – what they call "good-enough representations". Several studies have highlighted how focus can increase the extent, or impact of semantic analysis.

One of the earliest demonstrations of this used the Moses illusion by Erickson and Mattson (1981). The Moses illusion is perhaps one of the best known semantic anomaly, when participants are presented with 2.10, most incorrectly reply 'two' and fail to notice that it was in fact *Noah* who put the animals on the ark, not *Moses*.

2.10.   How many animals of each sort did Moses put on the ark?

Because participants were asked to read out loud and then verbally answer the question, they claim that the missed anomaly cannot be attributed to a failure of encoding the anomalous name. It also cannot be due to a lack of knowledge about who actually put the animals on the ark as participants' knowledge was checked in a post-test. Erickson and Mattson (1981) proposed that the illusion is only observed when the inconsistent name was semantically very similar to the correct name. This would explain why Noah could have been missed because Noah, like Moses, is a biblical character and so share similar semantic features.

A study (Bredart & Modolo, 1988), also using the Moses illusion, highlighted how focus influences the extent to which lexical-semantic and encyclopedic information is used. In order to discover whether or not focus modulates success at recognizing the anomaly in the Moses illusion, Bredart and Modolo (1988) compared the anomaly detection rates elicited by sentences whose focus is clearly placed on the inconsistent name, with the rates of illusion obtained with sentences whose focus is clearly placed on something other than the incorrect name:

2.11   Moses put two of each kind of animal on the ark.

2.12 It was Moses who put two of each kind of animal in the ark.

The materials were read out loud and participants were asked to verify these statements verbally (true or false). The results showed that higher rates of the illusion were elicited when the statements placed focus on something other than the inconsistent name. Even

placing MOSES or another word in capitals affects the likelihood of detecting the anomaly (Bredart & Docquier, 1989). These studies suggest that focus can increase the extent, or impact of semantic analysis (Bredart & Modolo, 1988; Bredart & Docquier, 1989; Barton & Sanford, 1993). A more recent investigation into the role of focus on anomaly detection used it-cleft constructions and unfocused, non-clefted constructions (Bohan, Sanford, Clark & Glen, in prep, Experiment 2). In the example below, the word vacated is anomalous in the context of an already empty table:

Introductory sentence	The restaurant manager regretfully told Mary that they were very busy and she would have to wait.
Focused version	It was the empty table by the window that was likely to be vacated in about twenty minutes.
Unfocused version	The empty table by the window was likely to be *vacated* in about twenty minutes.

When information pertaining to the anomalous word was placed in focus using it-cleft construction, detection of rates was higher at 77%, compared to 65% in the unfocused version.

So, if syntactic focusing devices serve to increase the extent of semantic analysis, placing inconsistent information in a less prominent position should receive less detailed processing. The related study by Baker and Wagner (1987) mentioned earlier investigated the effect of subordination on the evaluation of information for truthfulness. Participants were asked to verify a series of statements presented orally or visually. The

target sentence either contained false information in the main clause of the sentence

(2.13) or the false information was contained in the subordinate clause (2.14).

2.13   The Emerald City, the home of the Wizard of Oz, was named after the

precious *red* stone.

2.14.   The Emerald City, named after the precious *red* stone, was the home of

the Wizard of Oz.

Participants were less likely to notice false information when the sentence

structure signalled that the information was subordinate rather than of central importance.

This suggests that the structural characteristics of sentences do have an influence on

whether or not people evaluate information for truthfulness, less detailed processing

occurs when information is contained in a less prominent position.

A related argument has been made using a different technique borrowed from

visual perception. The change detection technique was adapted from the visual change

blindness paradigm, where participants are presented with consecutive displays of a

figure where some element is changed between displays. The studies by Sturt, Sanford,

Stewart and Dawydiak (2004) used short texts rather than visual scenes. This technique

has been used successfully to explore the role of attention and the detail of representation

in visual processing (e.g., Simons & Levin 1997; Hollingworth, Schrock & Henderson,

2001).   Sturt et al. (2004) presented participants with a target passage twice, with a short

delay between presentations, and they are required to report any words that change across

presentations.

Sturt et al. presented short passages, such as (2.15) followed by a target sentence that placed one of two noun phrases in a pseudo-cleft or a cleft construction (2.16, or 2.17).

2.15. Everyone had a good time at the pub. A group of friends had met up there for a stag night.

2.16. It was Jamie who really liked the *cider,* apparently. [Focus on Jamie]

2.17. What Jamie really liked was the *cider*, apparently. [Focus on cider]

The change was either to another word with a close semantic word change (beer) or to a more distant semantic word change (drink). They found that when cider was focused in 2.17, participants were more likely to notice the word change. Also, if the change had involved a large semantic change it was more likely to be detected. They also reported an interaction between focus and semantic relatedness, when a word was focused; small semantic word changes were more detectable (see figure 2.2).
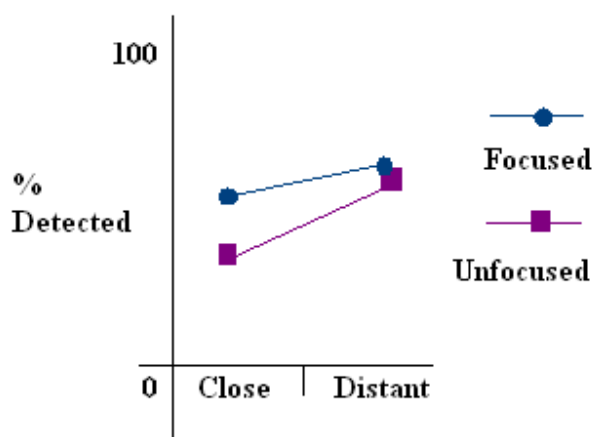

Figure 2.2: Illustration of the interaction between focus and semantic relatedness adapted from Sturt et al. (2004)

In a second experiment, they manipulated the prior context so that it focused the reader's attention on some aspect of the subsequent sentence. Again, participants read to successive presentation of a passage of text and state whether a change has occurred. The prior sentence either placed focus the reader on to the man in 2.18, whereas in 2.19, the focus is broader and on the general events. The target sentence was always identical and the word *hat* was changed to a close semantic word change or distant semantic word change (cap vs. dog).

2.18.   Everybody was wondering which man got into trouble (Focused)

2.19   Everybody was wondering what was going on that night. (Unfocused)

Target Sentence - In fact, the man with the hat was arrested

They reported similar results, with main effects for both focus and distance, and an interaction between focus and distance, such that close semantic changes were more detectable when the change was in a focus position.

Sturt et al. proposed the granularity theory as a way to explain the pattern of the interaction. The granularity theory (developing the ideas of Hobbs 1985) proposes that the meaning of a word may be represented at differing levels of granularity. For example, *a bird flying across a room* may be represented in some cases as a bird (coarse grain), in others as a small bird (medium grain), or as a sparrow (fine grain). In some situations a word may have been more extensively processed to finer level of granularity. Focus is one device in which can determine the level of granularity, so that when a word

is in focus, it tends to be more extensively processed, and hence represented in more detail.

Similar findings were presented by Sanford, Sanford, Molle & Emmott (2006) using auditory change detection: in the auditory version participants listened to two consecutive voices reading the same passage where one may change in the second reading. In the auditory version of materials adapted from Sturt et al. (2004) focus was manipulated via the prior context. In 2.20 the initial sentence asks the implicit question which money had been stolen. This places focus on the money contained in the wallet, and because the money in it is being discriminated from any other money.

2.20.   They wanted to know which money had been stolen.

2.21.   They wanted to find out what had happened.

The money from the *wallet* had gone missing.

Thefts in the area were becoming all too common.

When information is in narrow focus speakers naturally use a specific type of pitch accent, which begins low and rises to a high pitch on the stressed syllable (this is described as L+H* using Pierrehumbert's (1980) system of notation). In 2.20 stress was placed on the word wallet, but no stress was placed in 2.21. As illustrated below:

The money from the | Bank | had gone missing

The money from the | Bank | had gone missing
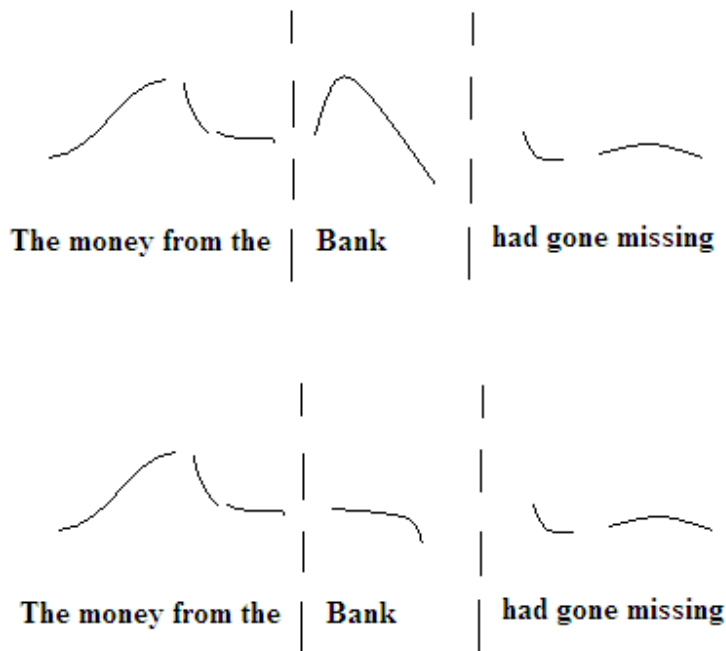
Figure 2.3 a simple schematic diagram to illustrate the differences between pitch track contours.

Participants listened to short passages as in spoken consecutively by male and then female speakers, where the critical word (wallet) changed to either a semantically close word (purse) or a distant word (bank). Sanford et al. replicated the results of Sturt et al. (2004), so that when wallet was in focus through vocal stress, participants detected more close word changes. Also, if the change was to a semantically distant word change, it was more likely to be detected. Finally, they reported a similar interaction, between focus and semantic distance, so that when a word was in focus it had a bigger effect on detection rates for close semantic changes than distant semantic changes.

In the text-based version, they used italicisation as an 'attention' capturing device. Italics are often used in texts to signify important upcoming information, and therefore may work in a similar fashion to the focus devices reported earlier. They reported main

effects for italics (focus) and semantic distance, and in line with the granularity theory, an interaction between italics and distance (close semantic changes were detected more frequently when italicised compared to the distant condition).

The results for both experiments supported earlier predictions of the granularity theory, that words may be placed in focus are represented in more detail, the argument being based on the interaction between semantic distance and focus manipulation.

Focus, Memory, and Availability

It has been suggested that clefting simply increases the strength of a representation in memory (Foraker & McElree, 2007). Using speed-accuracy trade-off estimates of accessing antecedents, these investigators concluded that clefting does not increase the speed with which the antecedent is accessed, but rather increases the likelihood that it will be retrieved. They use the term 'availability' to mean the distinctiveness of an antecedent representation in working memory. This definition of availability will be used throughout this thesis. They used the term 'accessibility' to refer to the speed of identifying a pronoun's referent within the discourse. Thus, clefting did not increase the speed of resolution (accessibility) but increased the strength or distinctiveness of an antecedent's representation in memory (Foraker & McElree, 2007, Sanford, Price & Sanford, in prep.).

There is other evidence that concepts within the scope of focus are more prominent in memory. Birch and Garnsey (1995) used it-clefts and there-insertions to investigate the effect of focus on memory. In experiments 1 and 2, they used a word recognition task to access whether target words are better remembered when they are in

focus. On each trial, participants read a sentence followed by a *target* word which participants had to verify whether it had appeared in the sentence.

2.22   It was the *system* that needed to be totally reorganized and updated.

2.23   There was this *student* who caused problems for the rest of the class.

The speeded recognition task was carried out immediately (experiment 1) or after reading a block of sentences (experiment 2). Participants were found to be faster at correctly identifying the word when it had been in focus than when it was not when tested immediately or after a delay. In order to rule out the possibility that the effects were due to processes triggered by the target, Birch and Garnsey (1995, experiment 3) used a naming task. Participants were required to state the target word out loud and the time and accuracy of the target's pronunciation was measured. Again, the same pattern of results was obtained, target words were pronounced faster and more correctly when the target word had been focused. Crucially, associates of the words in focus were not primed, suggesting that the distinctiveness of the representation of a word in focus is increased. Birch, Albrecht and Myers (2000) extended these findings by investigating focus effects against a neutral determiner and defocused condition. Using a sentence continuation task (Birch et al., 2000, experiment 1) measured whether placing a key element in focus or in a neutral determiner will affect sentence continuation patterns (see examples below).

As Joan walked home from the subway, she saw a crowd of people near her apartment building.

There was this mugger who had attacked an elderly lady…

A mugger had attacked an elderly lady…

Participants read brief stories and then had to continue the story by adding a sentence of their own. Participants produced more sentences referring to the focused referent compared to the neutral determiner.

Birch et al. also tested participants probe recognition to words contained in either a focused or a neutral-type version sentences using the same method by Birch and Garnsey (1995, experiment 1). Instead of finding facilitation in response times for the focused concepts, there was no evidence of heightened activation for the focused concept. They suggested that there was no room for focus to additionally increase the target concepts activation level. When they compared probe recognition for target words contained in focused, neutral or defocused conditions, responses to the focused concept were faster than the defocused concept but the focus and neutral conditions did not differ.

Birch et al (2000, experiment 4) also examined whether focus modulated longer-term memory representations for probe recognition. They compared probe recognition for target words contained in focused and neutral passages after a delay of a 10-second interval during which participants counted backward, making rehearsal impossible. The results showed that targets were recognized faster when the target word had been focused compared to target words contained in a neutral passage. This suggests that focus affects the long-term availability of concepts in memory.

There is some direct evidence to suggest that when a concept is made more available through being in focus, other elements are less available. Gernsbacher and

Jescheniak (1995) used a probe recognition task to explore whether placing vocal stress on a key element will lead to faster subsequent recognition of that word to the detriment of other concepts in the same sentence. They found slower recognition rates for other words mentioned earlier than the stressed word. Gernsbacher and Jescheniak claim that vocal stress enhanced the activation of a word, while suppressing the activation of other words.

They proposed two mechanisms that modulate the activation levels of incoming information, the first, enhancement increases or boosts the activation levels, the second, suppression, decrease or dampen the activation levels (e.g., Faust & Gernsbacher, 1996). These mechanisms are considered to be general cognitive mechanisms they have been shown to influence anaphora resolution (e.g., Gernsbacher, 1989; 1997) cataphora resolution (e.g., Gernsbacher & Jescheniak, 1995; Gernsbacher & Shroyer, 1989) lexical access (e.g., Gernsbacher & Faust, 1991a; Gernsbacher & St.John, 2002) as well as comprehending non-linguistic information (e.g., Gernsbacher & Faust, 1991b).

Using a cross-modal priming paradigm (Norris et al., 2006, experiment 4c) examined the effect of contrastive accent and found evidence that a word emphasized through stress produced increased priming compared to a word that was de-accented. However, in stark contrast to Gernsbacher & Jescheniak findings, other words in the sentences containing the accented word also showed increased priming. This pattern does not fit the notion of selective enhancement, nor a pattern of suppression. A recent study by Sanford, Price and Sanford (in prep.) using an auditory change detection task, investigated whether detection rates were adversely affected when a word is not within the scope of focus. They found that changes were much more readily detected when they

were made to elements within the scope of pseudo-cleft focus than they were to elements outside of the scope (through using a cleft construction). Furthermore, they also demonstrated that with cleft constructions, when an element was outside the scope of focus, it had reduced availability compared to a neutral control condition. Since this data is replicated numerous times in the present thesis, a fuller description is not given here. This data supports the notion that focus has a selective effect and supports the general stand taken by Gernsbacher & Jescheniak (1995) that mechanisms of enhancement and suppression modulate ease of reference.

Encoding and Focus: Eye-movement studies

Eye-tracking techniques have been used to investigate the possibility that there may be encoding explanations of focus. However, the results have not been particularly clear. While there is clear evidence that focus can ease integration processes, it is not clear whether focus leads to increased or decreased reading times.

For over a century, eye movements have been considered as a sensitive indicator of the reading process (e.g., Huey, 1908; Javal, 1879; Tinker, 1958). When readers process a page of text, their eyes do not move in a fluid movement across the page, but instead the movement, called a *saccade*, tends to be quite erratic, occasionally stopping to fixate a word. The eyes generally move forward about 7 to 9 character spaces with each saccade and fixations typically last between 150 and 500ms, but there is a considerable amount of variation within this range. Although most saccades in reading move forward, about 10 to 15 percent move backward and are termed *regressive saccades* (or *regressions*).

Regressive eye movements go largely unnoticed during normal reading; however, they serve important functions for language comprehension. Thus, while the majority of regressive eye movements are quite short, only going back a few characters, others require the reader to go back a considerable distance in the text to make sense of a major confusion (Rayner & Pollatsek, 1989). Therefore, variations in fixation times and regressions provide information on the level of difficulty for processing a piece of text. Rayner (1998) suggests that the ease or difficulty associated with processing a word is accurately reflected in the amount of time that readers spend looking at that word. The information gathered from studying eye movement behaviour can reveal important aspects of the cognitive processes occur during reading (Rayner & Pollatsek, 1989). In fact, Rayner and Pollatsek claim that eye movement data provides the best method to explore what people are actually doing when they read. Any immediate disruption in the eye movement record should be observed with early measures such as the duration of the first fixation, first pass reading times, and first pass regressions out. More sustained difficulties are more likely to be reflected in later measures such as total reading on a target word, second-pass reading times, regression path times and the number of regressions back to the word.

An early study of eye movements and focus effects had participants viewing pictures that corresponded to a previous sentence (Zimmer & Engelkamp, 1981). They listened to cleft sentences that placed one of two characters into focus before being presented pictures of both of these people. Participants spent longer viewing the character that had been focused in the previous sentence compared to the unfocused character. This suggests participants spent longer at the focused referent because it was

considered to be more important. This would suggest by placing a character in a prominent position, it signals the reader to mark the concept as having a 'privileged' status (Birch & Rayner, 1997).

A study by Birch and Rayner (1997) examined the effect of focus on participants' eye-movements. They manipulating focus using it-clefts or there-insertion devices using the materials used by Birch and Garnsey (1995).

2.24   It was the suburb that received the most damage from the ice storm.

2.25   Workers in the suburb hurried to restore power after the ice storm.

Unlike, the previous experiments, participants were not required to search for specific information and were simply to read for meaning while their eye movements were monitored. They found that focus did not affect any of the early eye-tracking measures. Instead differences emerged in later measures; participants' were more likely to reread an earlier portion of the sentence after reading a focused sentence compared to a non-focused one. They also had longer second-pass reading times when the target word was contained in a focus condition compared to a non-focused condition. However, the results by Birch and Rayner could be due to the fact the critical word was contained in different sentence frames in the focus and non-focus condition.

Birch and Rayner concluded that this longer second pass reading times indicated that focus affects the higher level processes involved with reading a word. Their idea was that the cleft constructions led to additional processing during reading, but only after a reader has accessed the word's meaning and had begun integrating it into its context.

One benefit of more careful encoding of focused information is to facilitate the integration of subsequent references to it.

Morris and Folk (1998) also investigated the impact of focus on participants eye movements. They also used it-cleft sentences in order to place the target word in focus. They also failed to find any differences between focused and non-focused words on early processing measures. They did find effects on later measures, but participants showed reduced reading times on the focused target word compared to the non-focused items. This they took to indicate that focused information was easier to integrate into the discourse representation than non-focused information. Foraker and McElree (2007, experiment 2) also investigated the effect of clefting, but they looked at pronoun resolution. They also failed to find any effects in early eye-tracking measures like Birch and Rayner (1997) and Morris and Folk (1998). Similar to the findings by Morris and Folk, regression path times, second-pass times and total reading times were all longer in the non-clefted condition compared to the clefted condition. No firm conclusions as to whether the exact nature of focus effects during reading leads to more careful or effortless encoding is possible.

Summary and Structure of thesis

Several studies have suggested placing a key element into focus either with syntactic devices or prosody increases the salience of the text information; this has been found with the use of wh-clefts (e.g., Birch & Rayner, 1997; Cutler & Fodor, 1979; Sanford, Price & Sanford, submitted, Sturt et al., 2004), it-clefts constructions (e.g., Birch

& Garnsey, 1995; Birch et al., 2000; Morris & Folk; 1998, Sturt et al., 2004, Sanford et al., submitted), pitch accent (Birch & Clifton, 2002) subordinate versus main clauses (Baker & Wagner, 1987; Cooreman & Sanford, 1996) and proper names (Moar, Sanford & Garrod, 1988).

As far as I am are aware, no studies have been conducted to investigate whether the aging process influences the utilization of information structuring and related cues. Older adults may use these cues extensively in order to function more effectively and efficiently in order to improve depth and quality of processing. Since focus information is used over a lifetime, it is also possible that it is preserved as a cue in older adults; it may be used to offset other difficulties by pointing the listener/reader to what is most important in a message. Alternatively, if selective attention is compromised, you might expect a decline in the use of information structuring to selective processing with age.

My concerns in this thesis are as follows:

- First, do older adults become less sensitive to information structuring cues, or perhaps, more sensitive?
- Secondly, is the effect of focus cues on various aspects of performance attenuated or exaggerated in the elderly?

A complicating factor is that any changes in performance levels under focus conditions may depend on base rate performance. For instance, if performance in the young with respect to a speed or accuracy measure is already very good, there is less

'room to improve' than there might be in the elderly who may have a poorer base level.

This is illustrated in figure 2.4.
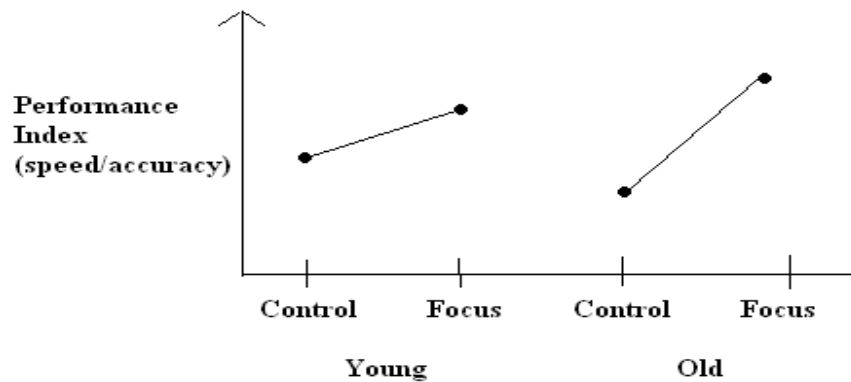
Figure 2.4 a simple schematic diagram to illustrate the differences in base-rate

performance.

Off-line methods can be a particularly useful in determining the overall

comprehension abilities (or deficiencies) of various populations (e.g., Love & Swinney,

1998). The main method used to answer the first question is a simple continuation task,

since this offers a straightforward indicator of sensitivity to focus cues. In order to

answer whether the effect of focus has a greater impact on the older age group, I

compared performance levels under focus conditions to base rate performance, using self-

paced reading, change detection and probe recognition. I also used eye-tracking, which is

a more on-line method that captures the moment-by-moment processing as it unfolds.

The final question is whether the performance findings generalize sensibly over the

different methods of assessment and over different varieties of emphasis (focus,

subordination, name/role distinction).

CHAPTER 3: INFORMATION STRUCTURING THROUGH CLEFT AND

PSEUDO-CLEFT CONSTRUCTIONS

INTRODUCTION

It is known that lexical, pragmatic and semantic factors influence syntactic processing in young and older adults, yet how ageing affects the use of certain linguistic cues is under-explored (Kemper & Liu, 2007, see chapter 1 & 2 for fuller reviews). Three experiments in this chapter examine how healthy ageing affects the use of focus cues. As far as I am aware, no studies have been conducted to investigate whether the ageing process increases reliance on focus cues, or reduces the capacity to use them. In the present experiments, I have outlined a direct way of testing the influence of information structuring (Pseudo-cleft and cleft constructions) on elements that are either within or beyond the scope of focus in young and older adults.

Experiment 1, using a sentence continuation task, investigated the effect of pseudo-cleft and cleft compared to baseline type sentences to check whether a preference exists for elements within the scope of focus, and whether this is present in the older sample. Experiment 2, using a self-paced reading task, investigated whether a focused character in a sentence affects processing anaphoric references in a subsequent target sentence which could either mention the focused or unfocused referent. Experiment 3, using an audio-change detection task, investigated how easily changes to words in either pseudo-cleft, cleft or baseline constructions were detected.

EXPERIMENT 1

Experiment 1 is a direct examination of focus through it-clefts, pseudo wh-clefts compared to a baseline. This was to establish whether marked cleft structures would result in any age differences in the use of the cue, and its effects.

Consider example (3.1). Here the implicit question it answers is, "*Who broke the vase*?" It is thus natural to process the sentence with a narrow focus on the first noun phrase (NP1), *Debra*, as it identifies a certain person from a set of implicit alternatives, providing a possible answer to the implicit question in the sentence. In sentence (3.2) the implicit question in its structure is, "*what did Debra break*?" So, it is natural to process the sentence with a narrow focus on the second noun phrase (NP2), *the vase*, as it identifies an object that can answer the implicit question in the sentence. Sentence (3.3) has a broad focus on the proposition expressed by the whole sentence.

3.1   It was Debra who broke the expensive vase. (Cleft version)

3.2   What Debra broke was the expensive vase. (Pseudo-cleft version)

3.3   Debra broke the expensive vase. (Baseline version)

Cleft constructions place implicit emphasis on NP1, whereas the pseudo-cleft constructions place emphasis on NP2. However, in the baseline construction there is no implicit emphasis on either NP. Experiment 1 examined the effect of Focus (cleft vs. pseudo-cleft vs. baseline), and Age (young vs. older) on sentence continuations.

Method

Design and Materials

There were thirty-six experimental materials in three different files each containing twelve items (see table 3.1 for examples).   Each file contained one of the possible versions of each item, but overall contained an equal number of all conditions.

Table 3.1 Examples of the type of experimental materials used.

Pseudo-Cleft version	Cleft version	Baseline
What John stole was a valuable painting.	It was John who stole a valuable painting.	John stole a valuable painting.

One version of each item was assigned to one of three files. The 36 experimental items were assigned to the files so that equal numbers of each condition appeared on each file, with only one version of each item appearing on each file, so that participants did not see more than one version of any given item. By rotation, all materials appeared in all conditions over the three files.

Participants

24 younger adults (mean age = 20, 16 women, 8 men) with an age range of 18 to 25 years old and 24 healthy older adults (mean age = 78, 22 women, 2 Men) with an age range of 65 to 91 years old from the Glasgow University community took part. Older participants were reimbursed any transportation expenses. All were native English speakers with normal or corrected-to-normal vision.

They also completed the National Adult Reading Test (Nelson, 1982) and demographic information such as occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was slightly higher for older adults (mean predicted I.Q = 114.54, S.D = 4.11) than younger adults (mean predicted I.Q = 116.79, S.D = 7.84), t (46) = .602, p = .550) but this was not significant. The mean score of the participants' years of education was slightly but significantly higher for younger adults (mean years of education = 15.63, S.D = 1.74) than older adults (mean years of education = 12.25, S.D = 4.54), t (46) = 3.399, p= .001).

Procedure

Participants were given written and verbal instructions describing the experimental procedures, and were given a consent form to sign. They were given an 8-page booklet which contained the sentences, with a space below on which a continuation could be written. They were asked to continue each of the sentences with a sensible whole-sentence continuation that fitted the theme of the first sentence. They completed the task in their own time.

The experiment took less than one hour to complete. The participants were made as comfortable as possible and told that they could take as many breaks as they wished if they got tired. All participants were debriefed as to the purpose of the study after they completed the experiment.

Results and Discussion

Data Treatment for statistical analysis

The frequencies of responding with continuations to the first noun phrase (NP1) or the second noun phrase (NP2) were used as the basis of data for inferential statistics, based on log-linear modelling (e.g., Howell, 2002). Log-linear models are particularly advantageous when there is a need to analyse categorical data, in which a single event can have two or more possible outcomes. The model combines the features of a traditional chi-square test (e.g., examining the relationship between observed and expected cell counts) with those of analysis of variance (e.g., exploring interactions and main effects within a factorial design).

Like standard chi-square tests, log-linear analysis does not rely on parametric assumptions such as the normality of population distributions, and unlike analysis of variance, they are optimal for the analysis of categorical frequencies. Whereas ANOVA models cell means, log-linear analysis models cell frequencies, and as a result does not have an error term. It examines the pattern of observed cell frequencies, and whether this involves the dependent or independent variables and their interactions.

The following equation was used to characterise biases in responding with NP1 or NP2 continuations in each of the three conditions:

$$\text{LOGIT (NP1)} = \log \frac{p(\text{NP1})}{p(\text{NP2})}$$

A value above zero indicates a bias towards producing a sentence continuation referring to NP1, a value below zero indicates a bias towards producing a sentence continuation referring to NP2. Sentence completions were coded as either 'classifiable' (i.e. the sentence contained a clear reference to either NP1 or NP2) or 'unclassifiable' (i.e. the sentence was ungrammatical or could not be classed). All trials where the sentence completions were classified as 'unclassifiable' were excluded from further analysis (this accounted for only 2.3% of the data).

Log linear analysis was carried out on the logit values by participants (F1) and items (F2) treating age (young vs. old) as the between subject factor, and focus (cleft vs. pseudo-cleft vs. baseline), as a within-participant and within-item factor.

It is clear from figure 3.1 that both age groups show a strong bias towards producing a continuation to NP1 in the cleft and baseline conditions. Furthermore, participants in both age groups appear to show a strong bias towards producing a continuation to NP2 in the pseudo-cleft conditions.
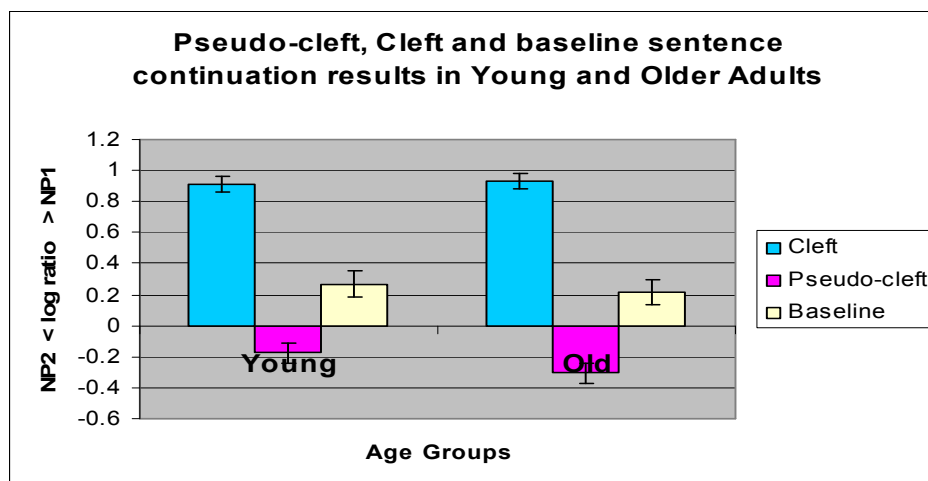

Figure 3.1 shows the mean log ratio sentence continuations and standard errors for the cleft, pseudo-cleft, baseline conditions at each age level.

The difference over conditions is highly reliable, with F_1 (2, 46) = 24.857, p <.0001; F_2 (2, 34) = 27.668, p<.0001. There was no effect of age, with F_1 (2, 46) = .034, p = .854; F_2 (2, 34) = .250, p = .619, and no focus/age interaction was found F_1 (2, 46) = .278, p = .600; F_2 (2, 34) = .581 p =.448.

Participants at each age level were significantly more likely to refer to NP1 than NP2 in the cleft and baseline conditions respectively, and in the pseudo-cleft condition participants were more likely to refer to NP2. In order to fully tease this issue apart separate analysis was conducted comparing the focus conditions to the baseline condition.

Pseudo-Cleft vs. baseline comparison

The pseudo-cleft sentence structure caused both young and older readers to produce more NP2 responses when compared to the baseline. Additional analysis was carried out in order to resolve this issue on the cleft and baseline conditions.   Log linear analysis was carried out on the logit values by participants (F1) and items (F2) treating age (young vs. old) as a between subject factor and Focus (Pseudo-cleft vs. matched NP) was treated as a within-participant and within-item factors. There was a main effect of focus; participants were more likely to refer to NP2 in the pseudo-cleft condition compared to NP2 in the baseline; with F_1 (1, 46) = 9.048, p = .004; F_2 (1, 34) = 9.047, p = .004. There was no effect of age, with F_1 (1, 46) = .252, p = .618; F_2 (1, 34) = .032, p = .852, and no focus/age interaction was found F_1 (1, 46) = .055, p = .816; F_2 (1, 34) = .495 p = .348.

<u>Cleft vs. baseline comparison</u>

In order to check whether the cleft structure results in both young and older readers to allocating more attention to the NP1 compared to baseline. Therefore, I conducted further analysis on the cleft and baseline conditions. There was a main effect of focus, participants were more likely to refer to NP1 in the Cleft condition compared to NP1 in the baseline; with F_1 (1, 46) = 24.914, p<.0001; F_2 (1, 34) = 34.549, p<.0001. There was no effect of age, with F_1 (1, 46) = .278, p = .600; F_2 (1, 34) = .242, p = .608, and no focus/age interaction was found F_1 (1, 46) = .278, p = .600; F_2 (1, 34) = .010 p = .919.

The rationale behind this experiment was to explore whether older participants, like their younger counterparts, were sensitive to focus cues as an attention-directing device. There was a clear effect of focus; both age groups were more likely to mention NP1 in the cleft and baseline conditions, whereas in pseudo-cleft condition, they were more likely to mention NP2. When separately comparing both of the cleft constructions to the baseline, participants at each age level were more likely to refer to NP1 in the cleft condition; whereas with the pseudo-cleft condition, both age groups more likely to refer to NP2. There appeared to be no evidence of any exaggerated enhancement through the use of focus cues in the older or younger sample.

There is thus clear evidence, when measured using a sentence continuation task, that information contained within the scope of focus is treated as having privileged status by both age groups. In this experiment I was simply interested to see whether older adults were responsive to focus cues. In the next experiment, I am interested in whether an element of a sentence is made more accessible through being in focus. I also address

the question of whether other elements are made less accessible. As I have shown that cleft structures can affect sentence continuation patterns in the older age group, I now move onto measuring the time it takes to read a sentence containing anaphoric references to either the pseudo-cleft, cleft or baseline type sentences.

To test the hypothesis that focus enhances processing, I examined participants' reading times for the focus conditions. I also compared the focus and baseline conditions separately in order to examine whether there is any evidence of enhancement and suppression, and whether the effects are the same or different for the two groups. I would predict that participants' average reading times should be faster when the target sentence is coherent with the elements within rather than outside of the scope of focus.

EXPERIMENT 2

Method

Design and Materials

A total of 36 materials were created, consisting of pairs of sentences. Sentences were devised in which two characters (one male and one female) were portrayed as interacting in a social scene. Of the names used, half were stereotypically female and half were stereotypically male. Each first sentence could appear in the form of a pseudo-cleft, cleft or baseline, as shown in table 3.2.

The final (target) sentence describing events consistent with NP1 are highlighted in bold whereas events consistent to NP2 are highlighted in italic (for illustration purposes only and did not appear during the experiment). This was then

followed by a comprehension question that either referred to NP1 or to NP2 in order to check that participants were reading the sentences for the sake of comprehension. Half of the questions were designed to give a Yes answer and other half were designed to give a No answer. In the Pseudo-cleft version, implicit emphasis was always on NP2 as the answer to the implicit question, whereas in the cleft version, implicit emphasis was always on NP1. In the baseline version there is no implicit emphasis on either NP.

Condition	Focus/Baseline sentences	Anaphoric target sentences
Cleft (**focused NP1** or *unfocused NP2*)	It was John who lost his daughter.	**He**/*She* had wandered off in the park.
Pseudo-cleft (*focused NP2* or **unfocused NP1**)	What John lost was his daughter.	**He**/*She* had wandered off in the park.
Baseline (Matched NP)	John lost his daughter.	**He**/*She* had wandered off in the park.
QUESTION	Did he/she wander off in the zoo?	

Table 3.2 – Antecedent sentence types and anaphoric target sentences either consistent with **NP1** or *NP2*.

The 36 experimental materials were assigned to six different files each containing 6 items. Each file contained one of the six possible versions of each item, but

overall contained an equal number of all conditions, and so that participants did not see more than one version of any given item.   In addition to this there were 64 filler materials from an unrelated experiment. There were thus 6 conditions in all: 3 (antecedent sentence type) x 2 (anaphor referring to NP1 or NP2).

The study was designed to be analysed in two parts, by firstly comparing references to either the focused NP or the unfocused NP in both cleft and pseudo-cleft constructions.   The second part was to compare cleft and pseudo-cleft constructions with the baseline (unmarked) sentence to separate enhancement and suppression effects. In order to test specifically test for pseudo-cleft enhancement effects, the appropriate comparison is between target sentences referring to NP2 in the cleft case, compared to NP2 in the baseline case. Similarly, in order to test for pseudo-cleft suppression effects, the comparison was between the targets sentences that refer to NP1, and targets referring to NP1 in the neutral baseline case. In the cleft case, in order to check for enhancement, the logical comparison is between target sentences referring to NP1 times, while to check for suppression the comparison was between NP2 times.

Participants

32 younger adults (mean age = 22, 18 women, 14 men) with an age range of 18 to 28 years old and 32 healthy older adults (mean age = 71, 22 women, 10 Men) with an age range of 65 to 92 years old from the Glasgow University community took part in the experiment and were each paid £5. Older participants were also reimbursed any transportation expenses. All were native English speakers with normal or corrected-to-normal vision. The sample of participants did not take part in the previous experiment.

Participants were required to complete the National Adult Reading Test (Nelson, 1982). This was done in order to gauge basic intelligence level of all the participants. Demographic information such as occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was significantly higher for older adults (mean predicted I.Q = 117.69, S.D = 7.847) than younger adults (mean predicted I.Q = 113.20, S.D = 2.19), $t(62) = 4.199$, $p = .001$). The mean score of the participants years of education was significantly higher for younger adults (mean years of education = 16.5, S.D = 1.74) than older adults (mean years of education = 11.24, S.D = 3.62), $t(62) = 3.499$, $p = .001$).

Procedure

All participants were given written and verbal instructions describing the experimental procedures, and were given a consent form to sign. On any trial, the two sentences of a material were presented line-by-line on a PC laptop screen using E-Prime (Schneider, Eschman & Zuccolotto, 2002) where reading times were measured from sentence onset with millisecond accuracy.

At the start of each trial a fixation cross appeared on the left hand side of the screen. Participants pressed the spacebar, upon which the fixation cross would disappear and the first sentence was displayed. After reading it, they pressed the spacebar again to get the next sentence until both sentences had been seen. Successive sentences within a trial were presented beneath the previous one, but the previous sentence was erased from the screen.

Participants then had to answer a comprehension question in order to check that that they were reading the sentences for the sake of comprehension. Half of the questions were designed to give a Yes for correct answer which required them to press the Y key and the other half were designed to give a No for incorrect answer which required them to press the N key on the keyboard. They were encouraged to make an appropriate response as quickly as possible. The entire sequence of events was then repeated with the next story.

Participants were given a practice block of 8 trials which were similar in structure to the main materials. They were instructed that the interest lay in how quickly they answered the questions, but they were encouraged to read smoothly and fairly rapidly at their own normal reading pace (depending on individual reading speeds).

The experiment took less than one hour to complete. The participants were made as comfortable as possible and told they could take as many breaks as they wished if they got tired. They completed the task in their own time. All participants were informed afterwards as to the purpose of the study.

Results

Question Accuracy

There was a high proportion of correct answers to the comprehension questions on the critical materials (see table 3.3) and none of these numerical differences were statistically reliable.

Table 3.3 – Antecedent sentence types and the percentage of correct answers at each age level.

	Percentage correct for pseudo-cleft condition	Percentage correct for cleft condition	Percentage correct for baseline condition
Young	87.8	91.1	85.2
Old	86.9	92.3	84.3

General findings

An initial analysis was carried out to show effects of reference to the focused versus unfocused NPs of the cleft and pseudo-cleft conditions.
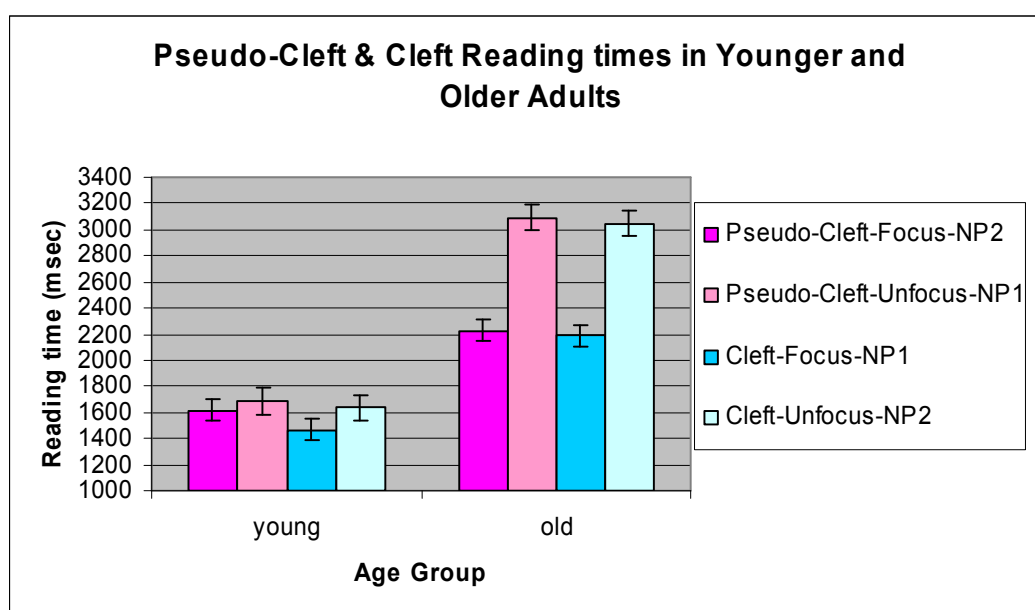

Figure 3.2 shows the mean target sentence reading times and standard errors for the cleft, pseudocleft and age conditions.

It is clear from figure 3.2, while older adults had overall longer reading times than younger adults, the pattern of results is similar for both age groups. Participants appear to show reduced reading times when the target sentence referred to the NP in focus. There does not appear to be a difference between the focus conditions; participants seem to respond faster to the anaphoric target sentence referring to the NP in focus. It appears both focus conditions facilitated the integration of an anaphoric sentence, when the target sentence referred to the focused NP in both age groups. In contrast, when the target sentence referred to the NP outwith the scope of focus, it clearly disrupted processing and seems to have had a greater impact on the older age group.

2 (Young vs. Old) x 2 (Cleft vs. Pseudo-cleft) x 2 (anaphor focus matches/mismatches) ANOVAs were computed for participants (F1) and items (F2) on reading times for anaphoric sentences.. There was a main effect of age; with $F1_{(1, 62)} = 36.64$, $p<.0001$; $F2_{(1, 34)} = 66.22$, $p<.0001$; older adults had significantly longer reading times than younger adults. The analysis shows that across conditions and groups, there is a significant effect of probe match/mismatch; with $F1_{(1, 62)} = 56.189$, $p <.0001$; $F2_{(1, 34)} = 103.288$, $p<.0001$; participants were significantly more likely to respond faster to the target sentence referring to the focused NP than the unfocused NP. There was an interaction between age and probe match/mismatch, with $F1_{(1, 62)} = 32.421$, $p<.0001$; $F2_{(1, 34)} = 16.920$, $p<.0001$. Both younger and older adults had shorter reading times when the target sentence referred to the focused NP. However, older adults displayed a sharper increase in processing time when the target sentence referred to the unfocused NP compared to younger adults. The analysis showed that there was no difference between the focus conditions (cleft vs. pseudo-cleft); with $F1_{(1, 62)} = 1.169$, $p = .284$; $F2_{(1, 34)}$

= .079, p = .780, no focus/age interaction was found; with $F1$ (1, 62) = .220, p = .641; F2

(1, 34) = .1.057 p = .308, no focus/probe interaction was found; with $F1$ (1, 62) = .220, p

= .641; F2 (1, 34) = .011 p = .918, and no age/focus/probe interaction was found; with $F1$

(1, 62) = .270, p = .605; F2 (1, 34) = 1.675 p = .200.

Bringing in the baseline: enhancement and suppression

In order to test specifically for enhancement effects, comparisons were made

between a target sentence referring to NP2 in the pseudo-cleft case, and targets referring

to NP2 in the baseline case. In the cleft case, comparisons are made between the target

sentences referring to NP1. To test for evidence of suppression, comparisons are instead

made between target sentences referring to NP1 in the pseudo-cleft case, and target

sentences referring to NP1 in the baseline version. To assess suppression in the cleft

items, comparisons were made between target sentences referring to NP2 in the cleft

condition and target sentences referring to NP2 in the baseline version.

Pseudo-Cleft Enhancement effect

As can be seen from figure 3.3, while older adults had overall longer reading

times than younger adults, the pattern of results is similar for both age groups.

Participants appear to show shorter reading times in the pseudo-cleft condition when

compared to the matched NP2 and this pattern seems slightly exaggerated in the older age

group.

A 2x2 ANOVA was carried out by participants (F1) and items (F2), Age (young

vs. old) was treated, using the target sentence reading times as the between subject factor

and Focus (Pseudo-cleft focused vs. matched NP) was treated as the within-participant

and within-item factors.
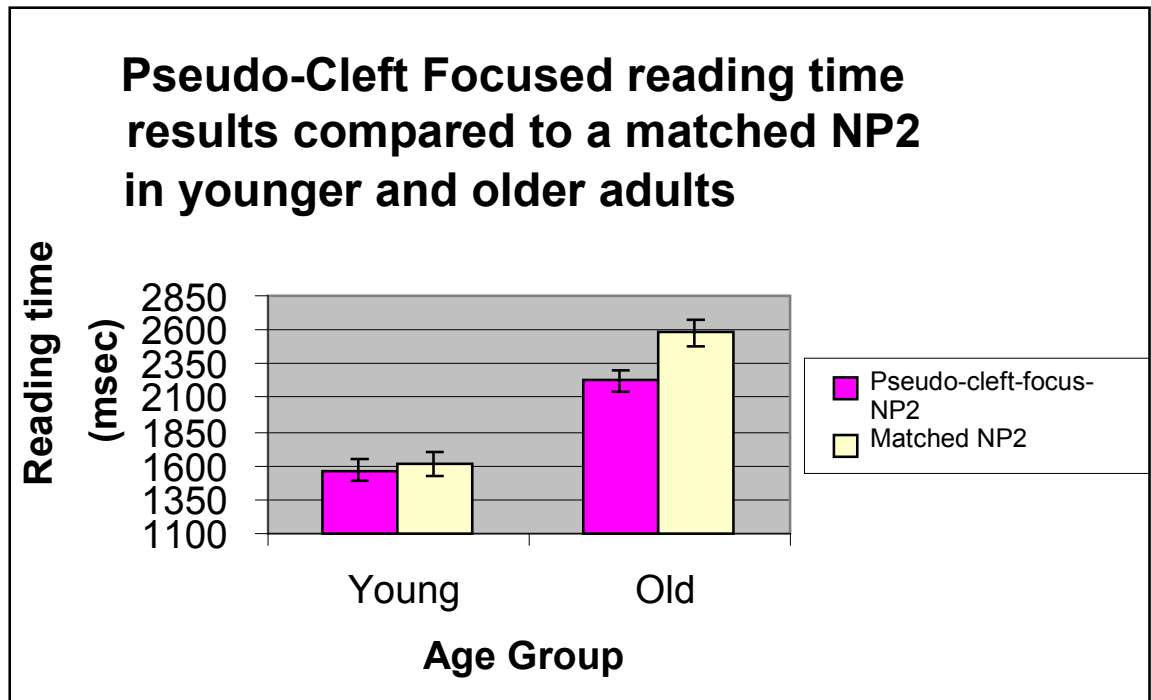
Figure 3.3 shows the mean target sentence reading times and standard errors for the

pseudo-cleft, and baseline conditions at each age level.

There was a main effect of age; older adults had significantly longer reading times

than younger adults, with $F1 (1, 62) = 18.585$, $p<.0001$; $F2 (1, 34) = 94.326$, $p<.0001$.

The analysis also showed that across conditions and groups, there is a significant effect of

focus. Participants were significantly more likely to respond faster to the focused

condition compared to the baseline, with $F1 (1, 62) = 7.282$, $p=.009$; $F2 (1, 34) = 9.814$,

$p=.003$. There is an interaction between age and focus, with $F1 (1, 62) = 4.223$, $p =$

$.044$; but this was marginal by materials with $F2 (1, 34) = 3.132$, $p = .082$. There was

thus a reduction in reading time relative to baseline when the NP in question was in

focus, and this was somewhat enhanced in the older age group.

Pseudo-Cleft Suppression Effects

As can be seen from figure 3.4, while older adults had overall longer reading

times than younger adults, the pattern of results is similar for both age groups.

Participants appear to show increased reading times in the unfocused condition when

compared to the matched NP1 and this pattern of suppression seems stronger in the older

age group.

Figure 3.4 shows the mean target sentence reading times and standard errors for the

pseudo-cleft, and baseline conditions at each age level.

A 2 (young vs. old) x2 (Pseudo-cleft unfocused vs. matched NP) ANOVA was carried out by participants (F1) and items (F2). There was a main effect of age; older adults had significantly longer reading times than younger adults, with $F1_{(1, 62)}$ = 31.212, p<.0001; $F2_{(1, 34)}$ = 34.166, p<.0001. The analysis also showed that across conditions and groups, there is a significant effect of focus. Participants produced significantly longer reading times to the unfocused condition compared to the matched NP1, with $F1_{(1, 62)}$ = 11.224, p=.001; $F2_{(1, 34)}$ = 7.588, p=.008. Participants had longer reading times in the unfocused condition compared to the matched NP1.

There was an interaction between age and focus; $F1_{(1, 62)}$ = 6.805, p = .001; but this was marginal by materials with $F2_{(1, 34)}$ = .654, p = .422. There was thus a suppression of processing relative to baseline when the NP in question was out of the scope of focus, and this was marginally a larger effect in the older age group.
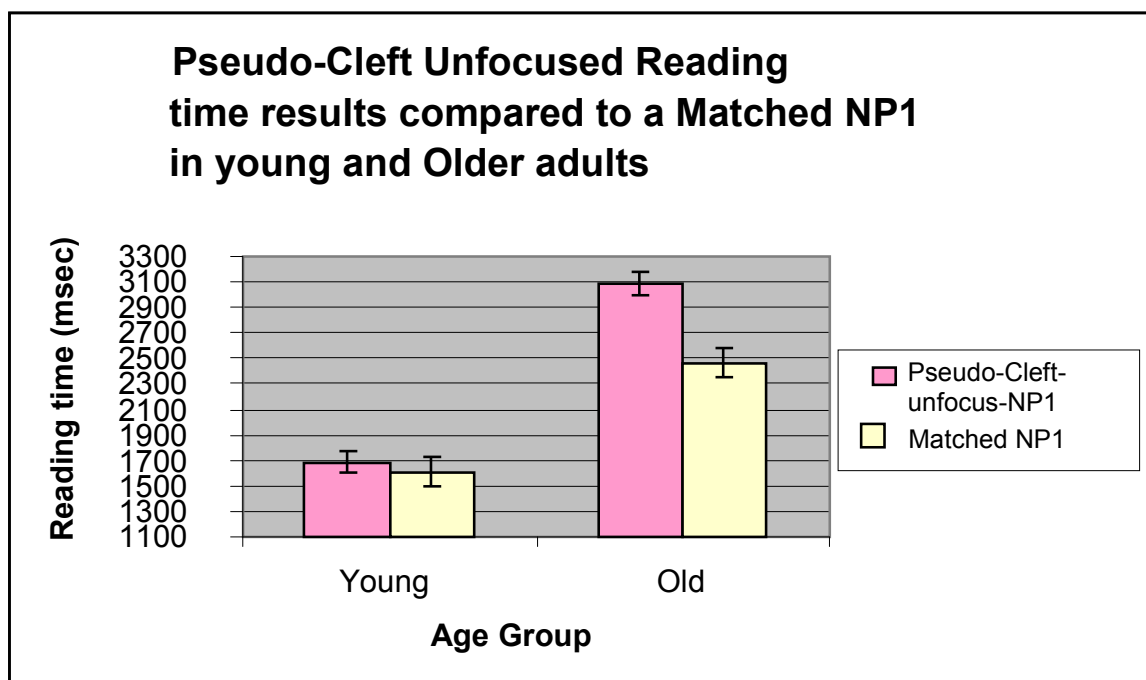
Cleft Enhancement Results

Figure 3.5 shows the mean target sentence reading times and standard errors for the cleft and baseline conditions at each age level.

As can be seen from figure 3.5, while older adults had overall longer reading times than younger adults, the pattern of results is similar for both age groups. Participants appear to show reduced reading times in the cleft condition when compared to the matched NP1.

A 2x2 ANOVA was carried out by participants (F1) and items (F2), Age (young vs. old) was treated, using the target sentence reading times as the between subject factor and focus (cleft focused vs. matched NP) was treated as the within-participant and within-item factors.

There was a main effect of age; with $F1 (1, 62) = 18.122$, $p<.0001$; $F2 (1, 34) = 49.950$, $p<.0001$. Participants had significantly shorter reading times to the focused condition compared to the matched NP1 control, with $F1 (1, 62) = 6.201$, $p=.015$; $F2 (1, 34) = 11.00$, $p=.002$. Finally, there was no interaction between age and focus; with $F1 (1, 62) = .689$, $p = .410$; $F2 (1, 34) = .873$, $p = .354$. There was thus no trend towards greater enhancement effects in the elderly sample.

Cleft Suppression effects

As can be seen from figure 3.6, while older adults had overall longer reading times than younger adults, the pattern of results is similar for both age groups. Participants appear to show increased reading times in the unfocused condition when compared to the matched NP2 and this pattern of suppression seems to be more

exaggerated in the older age group.

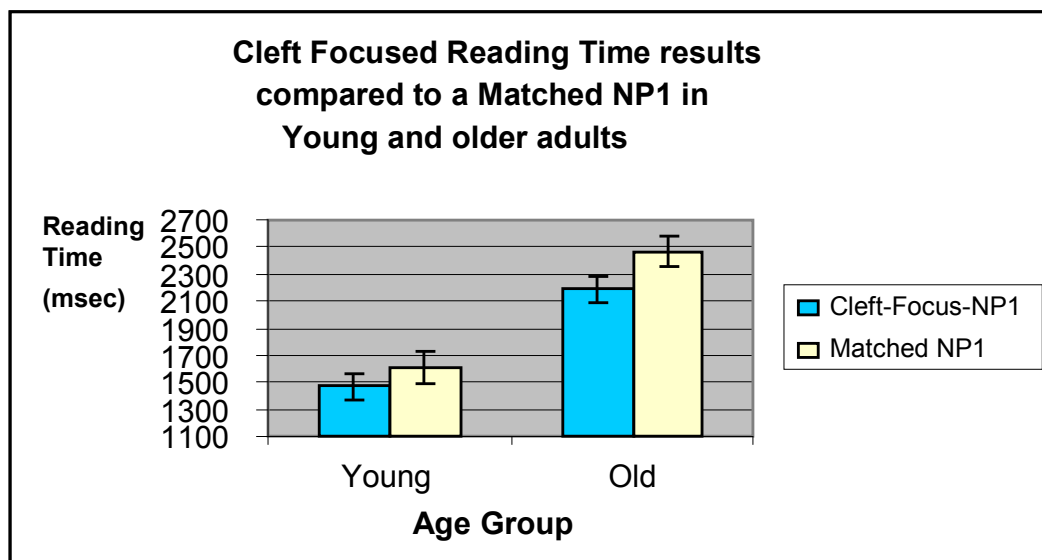**Cleft Unfocused reading time results compared to a Matched NP2 in Young and Older adults**
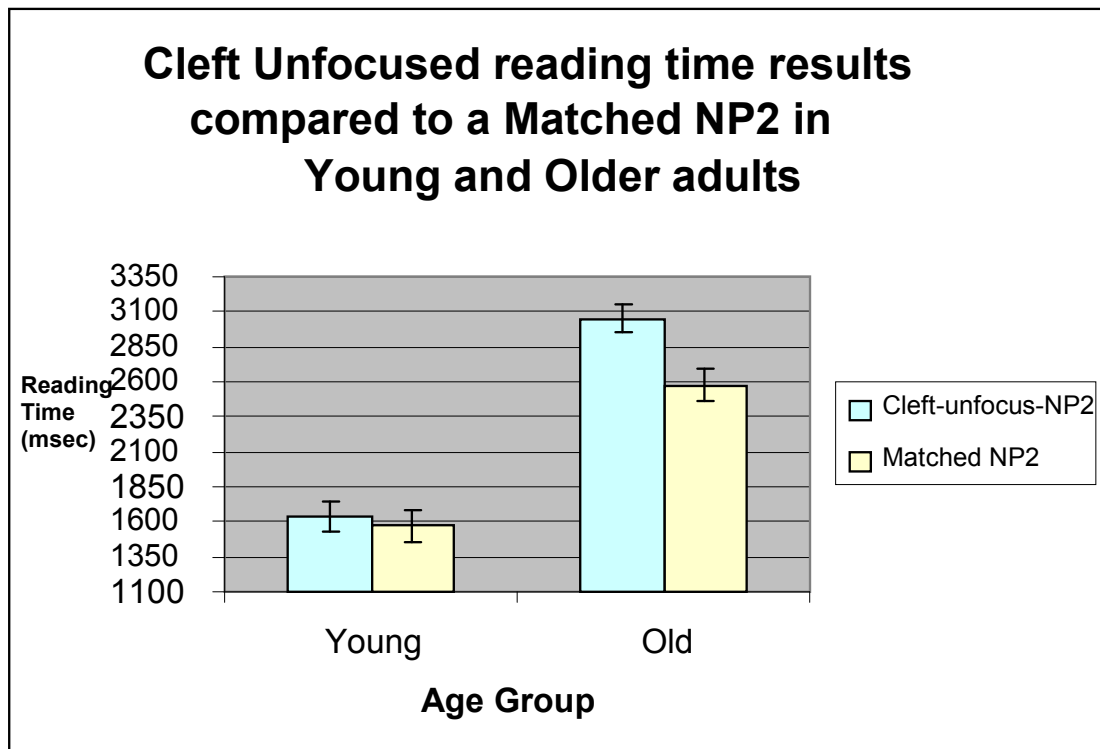
Figure 3.6 shows the mean target sentence reading times and standard errors for the cleft and baseline conditions at each age level.

A 2x2 ANOVA was carried out by participants (F1) and items (F2), Age (young vs. old) was treated, using the target sentence reading times as the between subject factor and Focus (cleft unfocused vs. matched NP) was treated as the within-participant and within-item factors.

There was a main effect of age; with $F_1 (1, 62) = 36.220$, $p<.0001$; $F_2 (1, 34) = 82.480$, $p<.0001$; older adults had significantly longer reading times than younger adults. The analysis also showed that across conditions and groups, there is a significant effect of focus; with $F_1 (1, 62) = 6.672$, $p = .012$; $F_2 (1, 34) = 5.227$, $p = .026$. Participants had

significantly longer target sentence reading times to the unfocused condition compared to the matched NP2. Finally, there is an interaction between age and focus; with F_1 (1, 62) = 7.012, p = .01; F_2 (1, 34) = 4.335, p = .036, with the older group showing a larger effect. There was a suppression of processing relative to baseline when the NP in question was beyond the scope of focus, and this effect was larger in the older age group.

DISCUSSION

Experiment 2 was concerned with whether the focusing mechanism of cleft and pseudo-cleft information structuring leads to effective enhancement and/or suppression. I examined the ease of integration of an earlier sentence with an anaphoric target sentence, where the earlier sentence had a marked focused structure placing a key element either within or outwith the scope of focus.

Focus facilitated the integration of an anaphoric sentence which can be clearly seen by the reduced reading times compared to the matched NP. Elements contained in the scope of focus were enhanced and in the case of pseudo-cleft focusing, the age effects are exaggerated, though this was not the case for cleft focusing. The opposite can be said for the case when the anaphoric referent was outside the scope of focus, for both age groups reading times were increased, relative to baseline. The pattern of suppression was much larger in the older age group compared to younger adults.

In Experiment 3, I investigated the issue of whether focus differentially influences the strength of the memory representation resulting from being within and outside of the scope the focus in the two age groups.

<u>EXPERIMENT 3: TEXT-CHANGE DETECTION</u>

Using the text-change detection paradigm, I was interested to discover whether change detection is adversely affected when a word is not within the scope of focus. In this, participants hear (or read) a brief text on two successive presentations. There may be a change to a word on the second presentation, and their task is to indicate when they detect a change (Sanford, 2002). To avoid the possibility of re-reading that might occur with a visual presentation, the materials were presented aurally.

<u>Method</u>

Design and Materials

The design of this study was a 3x2x2 mixed design to investigate the effects of focus (focused, **anti-focused** or baseline); semantic relatedness of the words that changed across presentations (Close vs. Distant) and age (young vs. older) on auditory change detection. More specifically, I compared the participants' detection rates for the focused, anti-focused and baseline conditions.

The phrase '**Anti-focus'** is being used here and in subsequent experiments in a purely descriptive basis without any theoretical implication. In the previous experiments, the cleft condition places implicit emphasis on NP1, therefore this could result in shifting focus off the word being changed (the noun of NP2). This could result in change detection being adversely affected because the word change is not within the scope of focus in a cleft sentence.

The second part of the analysis was a control condition in order to test for enhancement and suppression effects; I compared separately the participants' detection rates for the focus and anti-focus conditions to the baseline condition. There were 24 test items; each vignette consisted of three sentences, in which the second sentence always contained the critical word. Changes to one word were made in the second presentation of the material. The three focus conditions differed only in the syntactic structure of the critical sentence.

Focus was manipulated using cleft constructions, examples are given below:

[Focused construction]

3.4   Everyone had just got back from a long and tiring swim in the sea. What Simon sat down on was the chair near the beach hut. The picnic lunch was very welcome.

Changes: Chair → Seat (close), Rock (distant)

[Anti-focused construction]

3.5   Everyone had just got back from a long and tiring swim in the sea. It was Simon who sat down on the chair near the beach hut. The picnic lunch was very welcome.

Changes: Chair → Seat (close), Rock (distant)

[Baseline construction]

3.6   Everyone had just got back from a long and tiring swim in the sea. Simon sat

down on the chair near the beach hut. The picnic lunch was very welcome.

Changes: Chair → Seat (close), Rock (distant)

In (3.4), the focused (Pseudo-cleft) condition implicit emphasis was always on

NP2, in this case *chair* as the answer to the implicit question. Therefore changes to this

word are more likely to be noticed. Whereas in (3.5), the anti-focused (cleft) condition

implicit emphasis was always on NP1, in this example it would be *Simon* as the answer to

the question, therefore shifting focus off the chair and decreasing the likelihood of change

detection. In (3.6), the baseline version there is no implicit emphasis on either the *chair*

or *Simon*. Therefore, it's predicted that detection in the baseline sentence will be less

than that found in the focused sentence, but greater than that in the anti-focus sentence.

Semantic relatedness was also manipulated by changing the relevant noun to a

semantically related (close) or semantically unrelated (distant) word. In the above

examples; *seat* would be a close change and *rock* would be a distant change.

The semantic distance variable was assessed over the word sets by pre-testing for

differences in perceived semantic distance. Twenty independent participants rated the

semantic relationship between the original word and the close and distant changes on a 10

point scale, low ratings indicating dissimilarity and high ratings similarity. The ratings

were made with the words shown within the context of the test items. The overall rating

for the close was mean = 7.94, (S.D = 1.46) and for the distant mean = 2.26, (S.D = 1.30).

Since word frequency and length might also influence the likelihood of detecting

a change, these were matched over the original, distant and close changes by determining

how frequently each word occurred in the British National Corpus (900 million words).

The mean log frequencies of occurrence per million were: original = 3.03 (se = .15),

close change = 3.01 (.16), distant change = 3.21 (.19). A one-way ANOVA carried out

on these frequencies showed no reliable difference ($F<1$). Further, the words were

approximately equated for length: first by number of letters (original = 5.63, close = 5.67,

distant = 5.33) and secondly by number of syllables (original = 1.54, close = 1.67, distant

= 1.63). Two separate one-way ANOVAs showed no reliable differences (both $Fs<1$).

In addition to the 24 test materials, 24 items with the same 3 constructions were

created ("matched fillers"), but these did not have a change on the second presentation.

A further 32 filler items with different structural configurations were used, and 24 of

these contained very obvious changes ranging over locations from early in the first

sentence to late in final sentence. The remaining 8 had no changes. Previous work (e.g.,

Sanford et al., 2004) showed that this mixture of fillers, with and without changes, was

good for eliminating prediction of when and where a change might occur. The items

were assigned to 6 play lists, each containing only one of the 6 possible versions of each

experimental item.

Recording

The recording of the materials and the analysis of the acoustic speech signals was

conducted by Alison Sanford and colleagues at the University of Strathclyde. The

materials were recorded by speakers from the Royal Scottish Academy of Music and

Drama to ensure the recordings were fluent and of clear voice quality. A male voice was

used for the recording of the first presentation, and a female for the second, to minimise

the possibility of participants detecting surface changes. Speakers were asked, when reading the materials, to consider the point of the story (i.e. who was the main character or what was the theme) and to read the materials clearly and naturally. A 5 second interval followed each pair of items on the recording. The materials were arranged in the play lists in a fixed random order.

To establish that the manipulations of focus had been successful, data on the spoken experimental materials was obtained using PRAAT, a freeware program for analysis and reconstruction of acoustic speech signals. Measures of duration and changes in pitch contour (maximum – minimum fundamental frequency, F0) were taken from the speech record for each target word, when it was in the focused (pseudo-cleft), not in focus (cleft) or baseline conditions.

Examples of pitch accent occurring on the target words of the focus item are shown in Figure 3.7, which illustrate the annotated pitch contour (changes in the fundamental frequency, F0), with the critical word (*drawing*) separated out so that measures of duration and changes in pitch could be obtained.
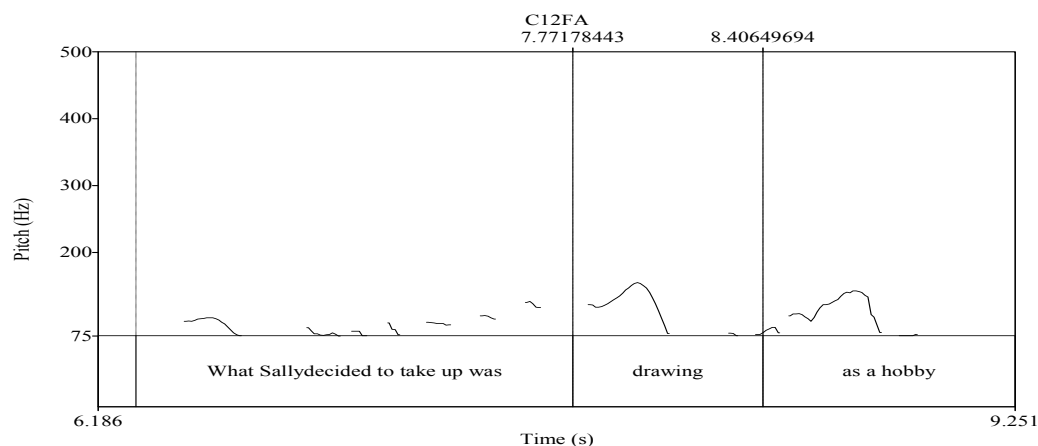
Figure 3.7 Example of annotated pitch track for experimental material in focused (pseudo-cleft) condition.

In the focus condition, the pitch accent on the word *drawing* rises sharply before falling, forming what Ladd (1996) has described as the 'hat' shaped pitch contour. Note also that the duration of the critical word is longer, a typical indication of emphasis being added to a word. An example of annotated pitch track for experimental material in anti-focused (it-cleft) condition is shown in Figure 3.8.
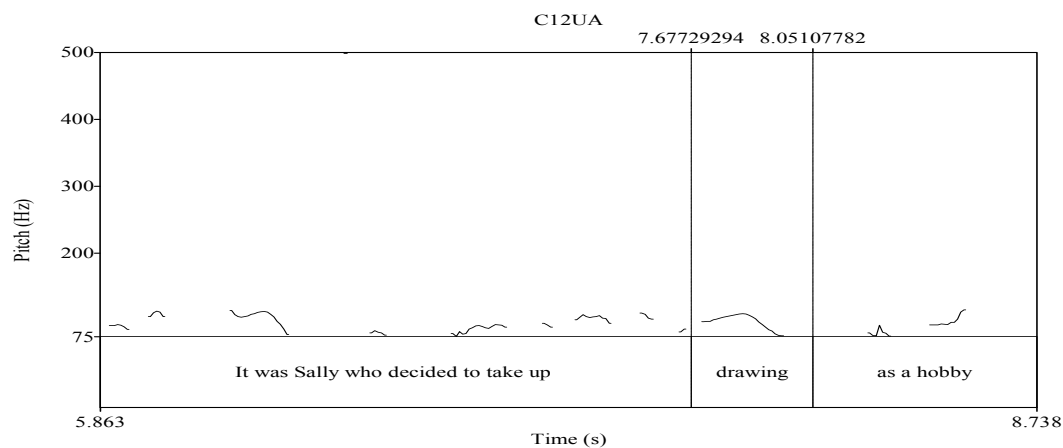
Figure 3.8 Example of annotated pitch track for experimental material in anti-focused (it-cleft) condition.

In the anti-focused (cleft) condition the main focus of the sentence is on the subject (Sally) rather than on the critical word, which receives less emphasis, resulting in smaller changes in pitch and shorter duration of the critical word. An example of annotated pitch track for experimental material in the baseline condition is shown in Figure 3.9. In the baseline condition, the pitch contour over the word *drawing* is relatively flat, and the duration is also shorter than that of the focused condition.
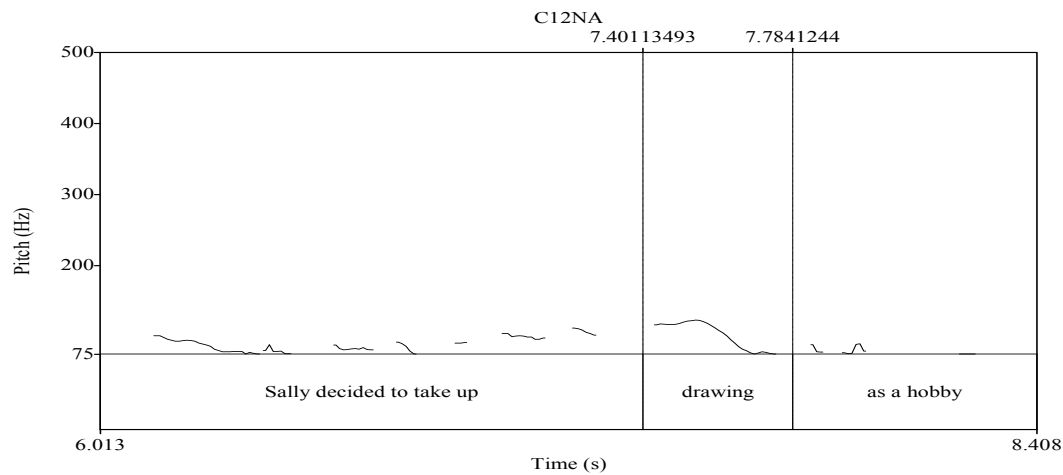
Figure 3.9 Example of annotated pitch track for experimental material in the baseline condition.

Analyses, using one way repeated ANOVA and post hoc analysis, showed that for Speaker A the manipulations of focus had resulted in longer durations of the critical word (p <0.001) when the word was the focus of the sentence than when the word was either outside of the scope of focus or the word occurred in the baseline condition (p <0.001). However, no differences in duration were observed between anti-focused and baseline conditions (p >.10). A similar pattern was obtained for changes in pitch, with larger changes in pitch occurring for critical words in the focused condition than the anti-focused condition (p <0.01) or the baseline condition (p <0.05). Differences in change in pitch were non significant between the anti-focused and baseline condition (p >.10).

Analysis of the speech data for Speaker B showed main effects for both duration (p <0.001) and changes in pitch (p <0.005). In both of the semantic distance conditions, longer durations of the critical word occurred when that word was in focus (p <.001) than

when the word was either outside of the scope of focus or the word occurred in the

baseline condition ($p <.001$). Again, no differences in duration were observed between

anti-focused and baseline conditions ($p >.05$).   The analysis of the pitch data, for both

close and distant related critical words, revealed larger changes in pitch for critical words

when they were in the focused condition than the anti-focused condition (close condition

$p <0.01$; distant condition $p <0.05$) or the baseline condition (close $p <0.05$; distant p

$<.001$). Differences in change in pitch were non significant between the anti-focused and

baseline conditions (close $p >.1$; distant $p >.05$).

Overall, these results show that critical words in the first or second presentation in

the focused condition had longer durations and larger changes in pitch than critical words

in the other two conditions. This pattern holds true for both speakers, and for speaker B

the pattern is consistent across both of the levels of semantic distance. Thus the expected

characteristics of pitch track ascribed to information structuring are present in the current

materials.

Participants

24 younger adults (14 women, 10 men) with an age range of 19 to 28 years old

and 24 healthy older adults (16 women, 8 men) with an age range of 65 to 81 years old

from the Glasgow University community took part and were each paid £5. Older

participants were also reimbursed any transportation expenses. All were native English

speakers' with normal or corrected-to-normal hearing. Participants were required to

complete the National Adult Reading Test (Nelson, 1982). This was done in order to

gauge basic intelligence level of all the participants. Demographic information such as

occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was slightly but significantly higher for older adults (mean predicted I.Q = 118.13, S.D = 3.46) than younger adults (mean predicted I.Q = 113.04, S.D = 2.91), t (46) = 5.5, p<.001). The mean score of the participants years of education was slightly but not significantly higher for younger adults (mean years of education = 16.13, S.D =2.61) than older adults (mean years of education =15.21, S.D =3.51), t (46) = 1.026, p=.310).

Procedure

Testing took place in a quiet room with only the experimenter and participant present. Before the experiment began the participant was given written instructions explaining that they were going to hear a series of vignettes, each repeated twice, and that some of the vignettes may have a small change the second time they heard it. Each participant listened to the 80 stimuli through a laptop computer; the sound was tested beforehand to insure the participant could hear the sentences clearly. After each pair of presentations of an item, the recording was paused and the subjects were asked whether they had noticed a change between the two vignettes and if so what the changes were. The experimenter was present throughout the whole session and noted down the participants' responses. Half way through the experiment, a five-minute break was given, although the participants were free to request a short rest at any time. All participants were informed afterwards as to the purpose of the study.

Results

Response types

A response was considered to be correct if the participant had detected a word had changed and had correctly stated what the word had changed too. If a change was reported that had not occurred, it was recorded as a false positive. To examine the number of false alarms as a sentence unfolds, each sentence was divided into five regions; so for example,

It was raining, and nobody was looking forward to going to work. What |John picked |up was his raincoat |before leaving the flat. |Everyone at the bus stop looked very miserable.

False Positives

It is clear from figure 3.10 that false positives were distributed widely and evenly over all the regions in the text for both young and older adults. It appears that the false alarms did not appear to involve words in any one particular location in the text.

False positives spread across the matched materials by young and older adults
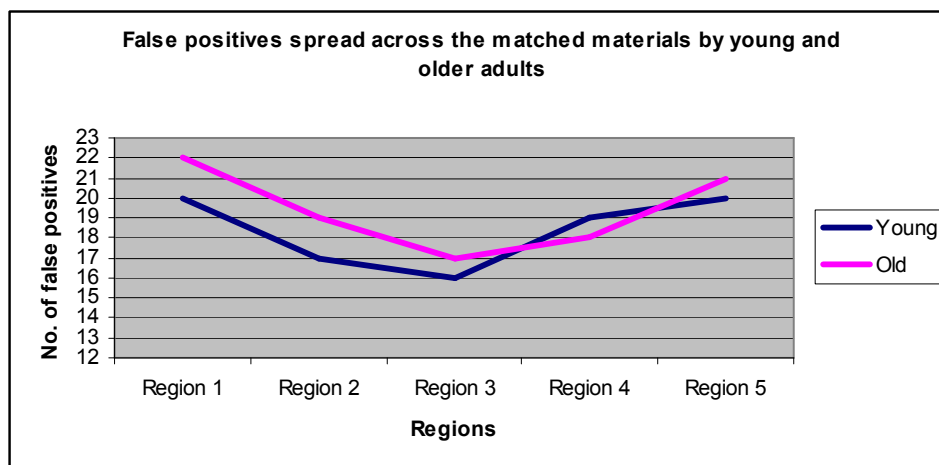
Figure 3.10 shows the pattern of false positives spread over the different regions at each age level.

Older adults made very slightly more false alarms (97 compared to 92) than younger adults, but the numerical difference was not statistically reliable.

Correct detections

As can be seen from figure 3.11, distant semantic word changes are detected more readily than close word changes, and this pattern is similar for both young and older adults. Both young and older adults seem to detect more changes in the focused condition compared to baseline, with least being detected in the anti-focused condition.

Focus, Baseline and Anti-focus change detection results in Young and Older adults
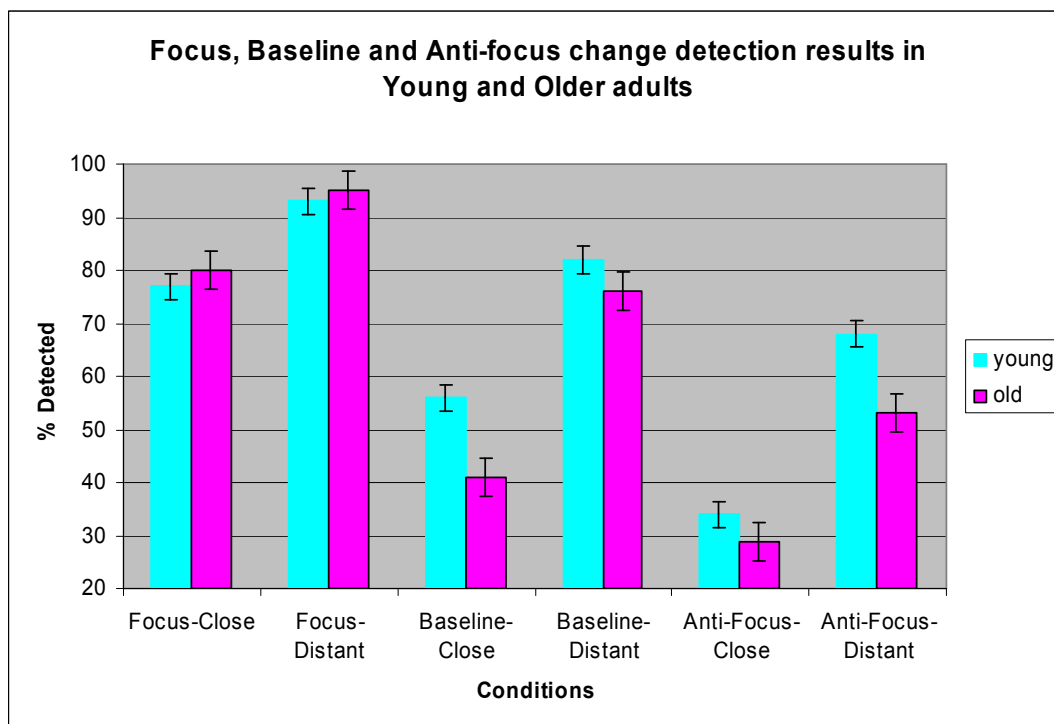
Figure 3.11 shows the mean change detections and standard errors for the focus, neutral and unfocused conditions at each age level.

3 (Focus vs. Baseline vs. Anti-focus) x 2 (young vs. Old) ANOVAs were computed on the arcsine of the proportion correct data by participants (F1) and items (F2).

There was no main effect of age, with F1 (1, 46) = .215, p=.645; F2 (2, 22) = .623, p = .434, older adults detected changes at a similar rate to younger adults. There was a main effect of focus; with F1 (2, 46) = 112.905, p<.0001; F2 (2, 22) = 36.46, p<.0001, with fewer detections in the anti-focused condition compared to that of the focused and baseline conditions in both age groups. There was also a main effect of semantic distance; with F1 (2, 46) = 141.107, p<.0001; F2 (2, 22) = 47.087, p<.0001, with distant semantic changes being more detectable than close semantic changes for both age groups. There was an interaction between focus and semantic distance; with F1 (2, 46) = 5.132, p = .008; F2 (2, 22) = 3.56, p = .036. Further comparisons (Bonferroni) showed greater rates of detection in the focused condition for semantically close and distant changes than in the anti-focused condition for semantically close and distant changes (*p*< .0001). They also showed greater rates of detection in the focused condition for semantically close and distant changes than in the baseline condition for semantically close and distant changes (*p*< .0001); all other differences were non-significant (*p*>.05). This interaction is consistent with the finding of Sturt et al. (2004) showing that semantic distance effects were less under focused than unfocused conditions. I shall return to this point later.

Focus and Baseline comparisons

Because the pattern of results for the close and distant word changes was the same for the two types of items; only the combined results will be presented here. In order to test for enhancement and suppression effects I carried out additional analyses separately comparing baseline and focus conditions for both age groups and the results extend the main findings, using 2x2 ANOVAS.

As can be seen from figure 3.12, older adults seem to have detected slightly more changes in the focused condition compared to the baseline condition compared to the younger adults. Both age groups detected more changes in the focused condition compared to changes in the baseline condition. It appears that in the baseline condition, older adults' performance drops more sharply than younger adults.

Focus and Baseline change detection comparisons in Younger and Older Adults
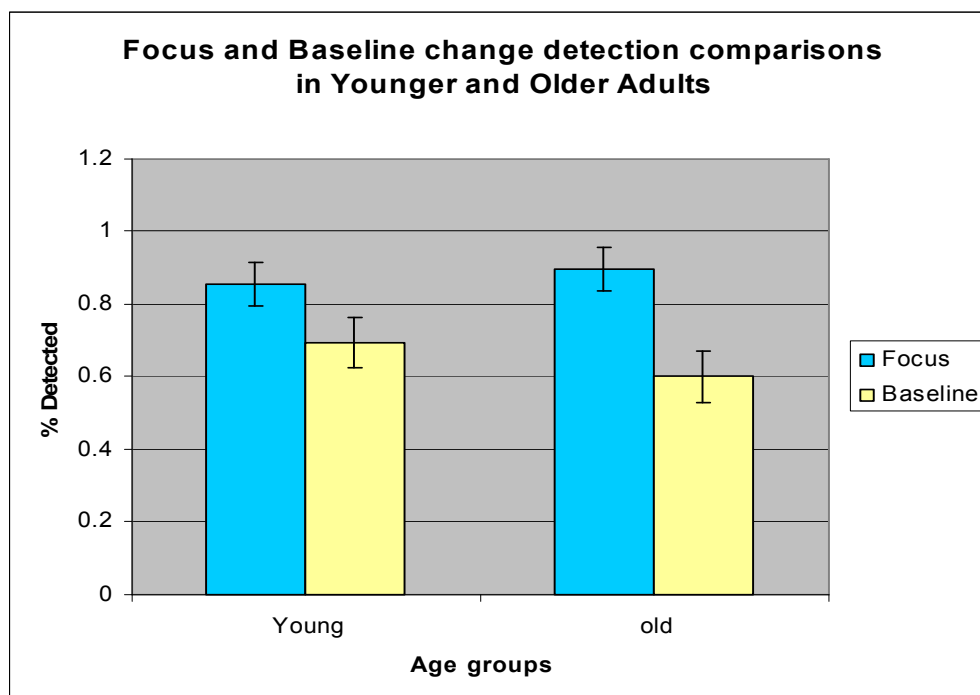
Figure 3.12 shows the mean change detections and standard errors for the focus and baseline conditions at each age level.

There was no main effect of age, with $F_1 (1, 46) = 1.021$, p=.318; $F_2 (1, 22) = 1.689$, p = .2. There was a main effect of focus, with fewer detections in the baseline condition compared to that of the focus condition in both age groups, with $F_1 (1, 46) = 150.224$, p<.0001; $F_2 (1, 22) = 47.577$, p<.0001. Importantly, there was also an interaction between age and focus; with $F_1 (1, 46) = 12.986$, p = .001; $F_2 (1, 22) = 3.860$, p=.055. Older adults had a sharper decline in detection rate when words were in the baseline condition compared to younger adults

Anti-Focus and Unfocused comparisons

As can be seen from figure 3.13, older adults seem to have detected fewer changes than younger adults; however, the pattern of results is similar for both age groups. Both age groups detected more changes in the baseline condition compared to changes in the anti-focused condition.
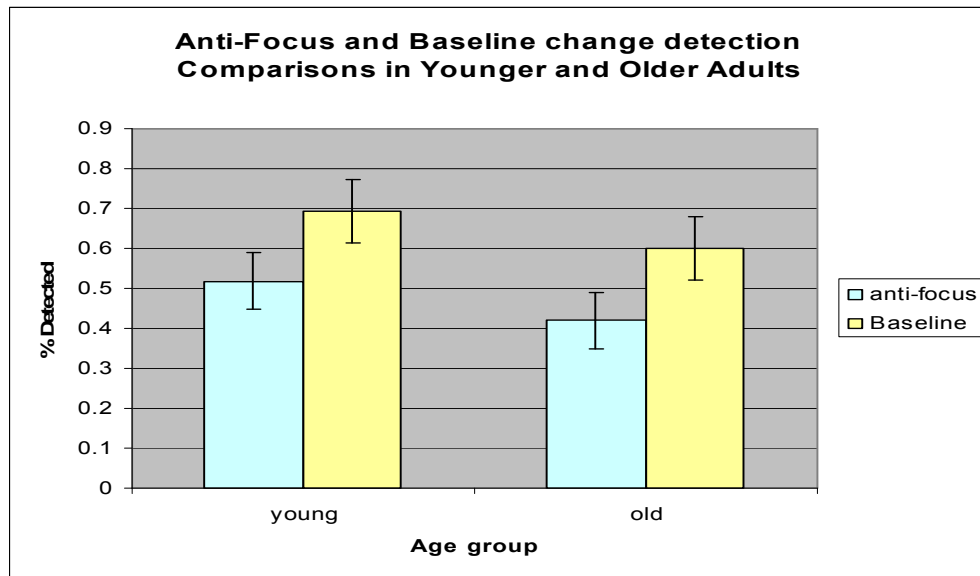
Figure 3.13 shows the mean change detections and standard errors for the anti-focus and baseline conditions at each age level.

There was a main effect of age; older adults detected changes significantly less changes than younger adults, with $F_1 (1, 46) = 10.524$, p=.002; $F_2 (1, 22) = 3.46$, p = .047. There was a main effect of focus with fewer detections in the anti-focused condition compared to that of the baseline condition in both age groups; with $F_1 (1, 46) = 63.146$, p<.0001; $F_2 (1, 22) = 14.326$, p<.0001. There was no interaction between age and focus; with $F_1 (1, 46) = 2.181$, p = .147; $F_2 (1, 22) = .014$, p=.905. Thus the suppression pattern is the same for both age groups.

DISCUSSION

The current experiment aimed at testing whether change detection is adversely affected when a word is not within the scope of focus, and how such an effect might be modulated by ageing. Changes were much more readily detected when they were made

to elements within the scope of focus than when they were outside the scope of focus. When the key element was within the scope of focus, for both age groups detection rates were increased, relative to baseline. Older adults also displayed a sharper decline in detection rates when words were in the baseline condition compared to younger adults. The opposite can be said for the case when the key element was outside the scope of focus, for both age groups detection rates were decreased, relative to baseline. The pattern of suppression was similar for both age groups. The current experiment suggests that focus has an impact on the memory strength of a noun phrase within its scope.

GENERAL DISCUSSION

In the present experiments, I have directly tested the influence of information structuring (Pseudo-cleft and cleft constructions) on elements that are either within or without the scope of focus in young and older adults. I was also able to test for how both selective enhancement and suppression might operate in young and older adults.

In the sentence continuation study (Experiment 1), I showed that relative to the baseline, both age groups were more likely to produce sentences referring to NP1 in the cleft condition and NP2 in the pseudo-cleft condition. This shows apparently equal responsiveness to the focus cues.

In the reading time study (Experiment 2), I showed that both cleft and pseudo-cleft constructions led to faster self-paced reading times for target sentences referring to elements that were within the scope of focus (enhancement), compared to baseline type sentence and that in some cases, the age effects are exaggerated. However, when elements were outside the scope of focus this lead to lengthened reading times

(suppression). The pattern of suppression was much larger in the older age group compared to younger adults. These findings support the general stand taken by Gernsbacher & Jescheniak (1995) that suppression as well as enhancement effects may modulate ease of reference (in their case, using probe recognition time).

I was able to examine the ease of integration of an earlier sentence with an anaphoric target sentence; however, no conclusions regarding memory strength for the in-and-out of focus items was possible. In order to resolve this issue, I investigated whether focus differentially influences the strength of the memory representation resulting from being within and outside of the scope the focus in the two age groups using a change detection task (Experiment 3). Both age groups detected changes much more readily when they were made to elements within the scope of focus than they were to elements outside of the scope. Older adults displayed poorer change detection rates when words were in the baseline condition compared to younger adults, showing that focus was effectively more advantageous, in performance terms, for the older group than for the young.

I also found evidence of an interaction between semantic distance and focus effects, replicating and extending the results found by Sturt et al., showing memory representations are relatively facilitated by focus, but reduced (suppressed) by anti-focus. This in turn is consistent with the view presented in Sturt et al. (2004) that focus serves to enhance the semantic specificity of representation of elements within its scope. This is also consistent with Foraker and McElree's (2007) claim that focus enhancement is the result of a more distinctive memory representation.

The results of these studies provide insight into whether older adults are as sensitive to focus cues as younger adults. Older adults showed a larger effect of focus, in terms of reading times, than did their younger counterparts. So, while off-line data indicates that older people are just as influenced by focus cues as their younger counterparts, in terms of processing, the effects are much greater. There was clear evidence of increased enhancement and suppression in the older sample in terms of reading times and change detection.

In the next chapter, I examine two things. First, whether a key element introduced within a focus structure is more available even after a delay than concepts introduced within a baseline or anti-focussed type sentence. Secondly, are focus effects due to encoding (tested through eye-movements). As before, I examine the possibility of an age-related differential.

CHAPTER 4: THE EFFECTS OF INFORMATION STRUCTURING ON EYE-

TRACKING AND LONGER TERM MEMORY

INTRODUCTION

In the present study, I was interested to see if a key element within or outside of the scope of focus will result in a longer term enhancement or suppression of its representation. Also, I was concerned to see whether the focus effects result from difference in encoding, indexed through eye-tracking. For instance, it is possible that the strong focus effects in the elderly result from disproportionately longer times being spent on material within the scope of focus.

Participants read a block of sentences while their eye movements were monitored. They then performed a delayed speeded recognition tests on the target words for the sentences in that block. This was to see whether focus, even after a delay, will affect the distinctiveness of elements in memory. I would predict that probe recognition in the baseline sentence will be less than that found in the focused sentence, but greater than that in the anti-focused sentence.

EXPERIMENT 4

Method

Participants

28 younger adults (mean age =21.5, 17 women, 11 men) with an age range of 18 to 31 years old and 28 healthy older adults (mean age =70.5, 18 women, 10 Men) with an age range of 61 to 86 years old from the Glasgow University community took part in the experiment and were each paid £6. Older participants were also reimbursed any transportation expenses. All were native English speakers with normal or corrected-to-normal vision. The sample of participants did not take part in the previous experiment.

Participants were required to complete the National Adult Reading Test (Nelson, 1982). This was done in order to gauge basic intelligence level of all the participants. Demographic information such as occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was significantly higher for older adults (mean predicted I.Q =118.43, S.D =3.33) than younger adults (mean predicted I.Q = 113.14, S.D =2.92), t (54) = 6.29, p<.0001). The mean score on the Wechsler Adult Intelligence digit span test (WAIS-III, the forwards and backward span scores were combined) was slightly but significantly higher for younger adults (mean digit span = 19.36, S.D =.82) than older adults (mean digit span =17.93, S.D =1.90), t (54) = 3.64, p=.001).[3] The mean score of the participants years of education was not significantly higher for younger adults (mean years of education = 16.29, S.D =2.74) than older adults (mean years of education =15.04, S.D =3.56), t (54) = 1.47, p=.147).

Materials and Design

The design of this study was a 3x2 repeated measures design to investigate the effects of focus (focused, anti-focused or baseline); and age (young vs. older) while measuring participants' eye movements, probe recognition and probe reaction time. The basic design is aimed at comparing the eye- tracking record, probe accuracy and reaction time in response to probe words (see table 4.1 for an example) under the focus, anti-focus and baseline conditions with each other.

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[3] Correlations between digit span and probe recognition accuracy produced only one significant trend in the younger age group and are given in appendix three.

The second part of the analysis was a control condition in order to test for enhancement and suppression effects; I compared separately the participants' probe recognition and reaction times to the focus and anti-focus conditions to the baseline condition.

Modified versions of the twenty-four experimental materials used in Experiment 3, plus twelve new items were used. In each condition, the first sentence acts as a context, introducing the scene with no emphasis on either NP1 or NP2. The critical sentence was either in the form of a focused (pseudo-cleft) sentence, or a baseline type sentence or an anti-focused (cleft) sentence.

Note that the final sentence in this case does not contain a sentence-initial anaphoric pronoun to either the NP1 or NP2. Probe words contained either in the focus; baseline or anti-focused contexts were displayed after participants finished reading a block of passages. Word frequency and length might also influence the likelihood of recognising a probe; these were matched by determining how frequently each word occurred in the British National Corpus (900 million words). The mean log frequencies of occurrence per million was 3.03 (se = .15) and the words were approximately equated for length by the number of letters (5.63).

One version of each item was assigned to one of three files. The 36 experimental items were assigned to the files so that equal numbers of each condition appeared in each file, with one version of each item appearing in each file, and so that participants did not see more than one version of any given item. The items were displayed with one hundred and eight filler passages and probes from an unrelated experiment. At least one filler item intervened between each experimental item.

Table 4.1 – Example of text passages followed by the probe word contained in either the focused, baseline or anti-focused context.

Focused	Baseline	Anti-focused
Most of the students had been concentrating on their revision. What Bill really wanted to pass was German, according to the teacher. The class test was going to be hard.	Most of the students had been concentrating on their revision. Bill really wanted to pass German, according to the teacher. The class test was going to be hard.	Most of the students had been concentrating on their revision. It was Bill who really wanted to pass German, according to the teacher. The class test was going to be hard.
Probe Word: German	Probe Word: German	Probe Word: German

Procedure

Participants' eye movements were tracked using a SR Research Desktop Mount Eyelink 2K eye-tracker. This had a spatial resolution of 0.01 degrees and eye position was sampled at 1000 Hz using pupil/corneal reflection tracking. Text (black letters on a white background, in a 20 point non-proportional font) was presented on a Dell P1130 19 inch flat screen CRT monitor with an 800 x 600 resolution. This was run at 170 Hz (5.88 ms per screen refresh). Participants were positioned at a viewing distance of approximately 72 cm, 3 characters of non-magnified test subtended 1 degree of visual angle. Although viewing was binocular, eye movements from the right eye were

recorded. Recordings were taken every millisecond. A chin rest was used to stabilize

participants' head position and to minimise interference caused by head movements

A calibration procedure was completed at the start using a series of nine fixed

targets distributed across the display, during which the participant was asked to fixate on

each point on the computer screen. A fixation spot ensured that when the text appeared

participants were looking at the start of the text. Adjustments to the calibration were

made during the experiment when the experimenter deemed it necessary.

There were twelve blocks of passages each containing in twelve passages. For

each passage, participants pressed the button in their right hand to begin the presentation

of the material and the passages were presented individually at their own reading pace.

After the twelve passages had been presented, the twelve recognition targets

corresponding to the twelve passages from the block were presented in the same order as

their corresponding passages.

Participants had to respond YES or NO as to whether the word had or had not

been present in one of the preceding twelve passages by clicking the button in their left

hand for YES or the button in their right hand for NO. They were instructed to respond

as quickly and as accurately as possible if they had seen the target but only if the target

had been contained within the immediately preceding twelve passages, even if they had

seen the word elsewhere in the experiment.

<div align="center">RESULTS</div>

Probe recognition

As can be seen from table 4.2, both young and older adults recognised more probe words when they were contained in the focused condition compared to baseline, with least being recognised in the anti-focused condition.

Table 4.2 Mean percentage correct detections for probes, with standard errors.

	Focused (Pseudo-cleft) probe	Anti-Focused (Cleft) probe	Baseline probe
Young	81.33 (1.25)	60.67 (1.57)	69.89 (1.63)
Old	87.33 (1.24)	56.33 (1.56)	75.78 (1.70)

ANOVAs were computed by participants (F1) and items (F2) on the accuracy data. There was no main effect of age, with $F1_{(2, 53)} = .636$, p=.429; $F2_{(2, 33)} = 1.249$, p = .268. There was a main effect of focus; with $F1_{(2, 53)} = 42.046$, p<.0001; $F2_{(2, 33)} = 22.33$, p<.001, participants recognised more probe words contained in focused condition followed by the baseline condition and lastly the anti-focused condition. There was no interaction between age and focus; with $F1_{(2, 53)} = 1.969$, p = .150; $F2_{(2, 33)} = .510$, p=.603.

In order to test for enhancement and suppression effects, we carried out additional analyses separately comparing baseline and focus conditions for both age groups and the results extend the main findings, using 2x2 ANOVAS.

Enhancement   There was no main effect of age, with $F1_{(1, 54)} = 2.74$, p=.104; $F2_{(1, 34)} = 1.637$, p = .205. There was a main effect of focus, with $F1_{(1, 54)} =$

20.33, p<.0001; F2 (1, 34)= 12.869, p=.001, participants recognised more probe words

contained in focused condition compared to the baseline condition. There was no

interaction between age and focus; with F1 (1, 54) = .001, p = 1; F2 (1, 34) = .247,

p=.621.

Suppression   There was no main effect of age, with F1 (1, 54) = .012,

p=.914; F2 (1, 34) = .160, p = .690. There was a main effect of focus, with F1 (1, 54)=

27.534, p<.0001; F2 (1, 34)= 3.856, p=.05, participants recognised fewer probe words

contained in anti-focused condition compared to the baseline condition. Importantly,

there was also an interaction between age and focus; with F1 (1, 54)= 4.634, p=.036; F2

(1,34) = 6.594, p=.012. Older adults had a sharper decline in probe recognition in the

anti-focused condition compared to younger adults.

Reaction Time to Probe

Table 4.3 Mean target recognition time and standard error.

	Focused (Pseudo-cleft) RT	Anti-Focused (Cleft) RT	Baseline RT
Young	1003 (240.3)	1405 (415.1)	1190 (294.4)
Old	1260 (307.5)	1634 (461.6)	1486 (447.8)

As can be seen from table 4.3, both young and older adults seem to respond faster

when the probe words were contained in the focused condition compared to baseline,

with longer reaction time to probes in the anti-focused condition.

2x2 ANOVAs were carried out by participants (F1) and items (F2). There was a main effect of age, with $F1_{(2, 53)}=13.544$, P=.001; $F2_{(2, 33)}=23.116$, p<.0001, older adults had longer reaction time to probe compared to younger adults. There was a main effect of focus, with $F1_{(2, 54)}= 22.241$, p<.0001; $F2_{(2, 33)}= 26.968$, p<.001. There was no interaction between age and focus; with $F1_{(2, 53)} = .155$, p = .857; $F2_{(2, 33)} = .032$, p=.858. Both younger and older adults had reduced reaction times to probe words contained in the focused condition followed by the baseline condition and lastly the anti-focused condition.

In order to test for enhancement and suppression effects we carried out additional analyses separately comparing baseline and focus conditions for both age groups and the results extend the main findings, using 2x2 ANOVAS.

Enhancement There was a main effect of age, with $F1_{(1, 54)} =13.153$, P=.001; $F2_{(1, 34)} =16.844$, p<.0001, older adults had longer reaction time to probe compared to younger adults. There was also a main effect of focus, with $F1_{(1, 54)} = 20.963$, p<.0001; $F2_{(1, 34)}= 17.311$, p=.001. There was no interaction between age and focus; with $F1_{(1, 54)} = .195$, p = .660; $F2_{(1, 34)} = .045$, p=.833. Both younger and older adults had reduced reaction time to probe words contained in focused condition compared to the baseline condition.

Suppression There was a main effect of age, with $F1_{(1, 54)} =13.563$, p=.001; $F2_{(1, 34)} =22.364$, p<.0001, older adults had longer reaction time to probe compared to younger adults. There was also a main effect of focus, with $F1_{(1, 54)} =$

10.147, p=.02; F2 (1, 34) = 7.77, p=.037. There was also an interaction between age and focus, with F1 (1, 54) = 3.604, p=.032; F2 (1, 34) = 4.526, p=.037. Older adults had increased reaction times to probe words contained in the anti-focused condition compared to younger adults.

Eye-tracking results

Regions of analysis The first and last sentences were treated as whole regions (introduction and end regions) and because these regions were so large and only served the purpose of setting the context and finishing the story, the data from these regions will not be reported. The critical second sentence was divided into 4 regions for the purpose of aggregating reading times and classifying eye- movements, as shown in (4.4). For each sentence frame, corresponding regions contained approximately the same number of words or characters in all three versions.

Focused	Baseline	Anti-focused
What |Bill really[1] |wanted to pass[2]| was German,[3]| according to the teacher.[4]|	|Bill really [1]|wanted to [2]|pass German,[3]|according to the teacher.[4]|	It |was Bill who[1]| really wanted to[2]| pass German,[3] |according to the teacher.[4]|

Table 4.4 Examples of each sentence type divided into four regions.

Region 1 was the *context region* which contained the NP1, however, any effects found in the context region have to be treated with caution. Firstly, they do not contain

the same number of words or characters across the three different conditions. Secondly, because of the position of the context region across the three conditions, the baseline condition is at the sentence initial position whereas in the other two conditions this is not the case. Region 2 (*pre-critical*) contained material that that led to the critical region. Region 3 (*critical*) always consisted of a noun, plus a further word and thus this region was always two words long. This allowed me to compare processing time on the same word in different context conditions. Region 4 (*post-critical*) comprised the critical sentence wrap-up.

The following measures (with definitions) were used to analyse the tracking patterns. *First-pass reading time* is sum of the time spent when first entering a region of text before leaving the region to either the left or right. First-pass reading times are considered to be an early indication of the difficulty experienced when first entering a region of text. *First-pass regressions out* measures the proportions of trials in which readers look back to previous sections of the text before progressing forward in order to examine the location of disruption in particular regions of a text.

Regression path time is the time spent from the first entry into that region before progressing to the next region and includes fixations made to re-inspect earlier portions of text. It provides an indication of the time spent re-reading after the initial detection of a problem. *Total reading time* is the total amount of time spent within a region and provides an indication of the overall amount of time spent processing text in that region. Finally, *regressions-in* measures the proportion of regressions back to a region from subsequent regions and indicates which regions of text readers need to revisit in order to make sense of a piece of text.

An automatic procedure pooled short contiguous fixations. Fixations shorter than 80ms were integrated with larger adjacent fixations within one character and fixations shorter than 40ms that were not within three characters of another fixation were excluded. Fixations longer than 2000ms were truncated. Trials where participants failed to read the sentence or there had been tracker loss were eliminated prior to analysis. Specifically, trials where two or more adjacent regions had zero first-pass reading times were removed, which accounted for less than 1% of the data reported here.

First pass reading times

	Context Region	Pre-critical Region	Critical region	Post-critical Region
Young Focused	906.38	1408.41	336.82	652.08
Young Anti-Focused	858.97	1447.75	337.17	658.73
Young Baseline	697.55	1473.46	356.85	653.92
Old Focused	1100.24	1645.57	378.28	671.18
Old Anti-Focused	1044.70	1753.77	381.67	768.82
Old Baseline	798.91	1733.68	365.15	733.28

Table 4.5 Mean first-pass reading times in the context, pre-critical, critical and post critical regions.

Context region   There was a main effect of age, with $F1_{(2, 53)} = 4.613$, P=.036; $F2_{(2, 33)} = 12.378$, p=.001, older adults had longer first pass reading times compared to younger adults. There was also a main effect of focus, with $F1_{(2, 53)} = 29.275$,

p<.0001; F2 (2, 33) = 66.629, p<.0001, participants spent longer looking at the focused

condition, followed by the anti-focused and lastly the baseline condition. This result has

to be treated with caution because of the differences in the number of words, character

length and position. However, the pattern of results is different from what may have

been expected, the anti-focused condition contains more words yet participants spend less

time overall reading the anti-focused condition. Participants also spend longer looking at

the focused condition compared to the baseline condition even though this region is

sentence initial in the baseline version. There were no significant interactions and in the

pre-critical, critical and post-critical regions there were no effects of condition on first

pass reading times [Fs < 1.2].

Total reading time

	Context Region	Pre-critical Region	Critical region	Post-critical Region
Young Focused	1084.98	1463.66	454.55	877.01
Young Anti-Focused	944.67	1494.70	402.42	815.19
Young Baseline	826.74	1444.01	443.37	830.34
Old Focused	1539.79	2032.49	639.19	1086.56
Old Anti-Focused	1400.03	2085.36	581.48	1155.09
Old Baseline	1208.30	2073.85	620.98	1179.49

Table 4.6 Mean total reading times in the context, pre-critical, critical and post critical

regions.

Context region There was a main effect of age, with F1 (2, 53) =27.582, P<.0001; F2 (2, 33)=58.545, p<.0001, older adults had longer reading times compared to younger adults. There was also a main effect of focus, with F1 (2, 53) = 39.918, p<.0001; F2 (2, 33) = 35.534, p<.0001, as with the first pass reading times in the context region, participants spent longer looking at the focused condition, followed by the anti-focused and lastly the baseline condition. There were no significant interactions and again, because of the differences in the number of words, character length and position, the results have to be treated with caution.

Critical region There was a main effect of age, with F1 (2, 53) =20.011, P<.0001; F2 (2, 33)=43.592, p<.0001, older adults had longer reading times compared to younger adults. There was also a main effect of focus, with F1 (2, 53) = 4.958, p=.011; F2 (2, 33) = 3.949, p=.025, participants spent longer looking at the focused condition, followed by the baseline and lastly the anti-focused condition. Thus, participants were more likely to spend more time reading a focused region and this indicates that they needed to carry out extra processing in order to ease integration or higher level processes in the focused case. There were no significant interactions and in the pre-critical and post-critical regions there were no effects of condition on total reading times [Fs < 1.2].

Regression out

Table 4.7 shows the mean number of regressions out per region for each condition.

	Context Region	Pre-critical Region	Critical region	Post-critical Region
Young Focused	2.43	21.60	25.48	20.56
Young Anti-Focused	2.36	13.22	18.52	18.44
Young Baseline	3.20	17.44	21.98	19.95
Old Focused	3.73	32.22	31.46	54.36
Old Anti-Focused	3.78	22.47	25.59	53.32
Old Baseline	2.30	32.62	26.86	61.06

Critical region   There was a main effect of age, with F_1 (2, 53) =14.307, P<.0001; F_2 (2, 33)=21.69, p<.0001. Older adults made more regressions compared to younger adults. There was also a main effect of focus, with F_1 (2, 53) = 8.386, p=.001; F_2 (2, 33) = 7.746, p=.001, there was a higher probability that a regression would be triggered out of a focused region, followed by the baseline, and lastly the anti-focused condition before progressing forward. This result indicates both young and older adults were more likely to reread an earlier portion of a sentence after reading a focused sentence. There were no significant interactions and in the context, pre-critical and post-critical regions there were no effects of condition on regressions [Fs < 1.2].

Regression path

Table 4.8 Mean regression path times in the context, pre-critical, critical and post critical regions.

	Context Region	Pre-critical Region	Critical region	Post-critical Region
Young Focused	937.22	1438.21	464.08	955.83
Young Anti-Focused	880.70	1458.90	400.23	814.86
Young Baseline	733.70	1486.34	442.57	874.37
Old Focused	1143.25	1708.05	645.09	1040.15
Old Anti-Focused	1116.87	1832.71	512.33	1094.70
Old Baseline	841.82	1854.74	565.10	1063.42

Context region There was a main effect of age, with F_1 (2, 53) =5.301, P=.025; F_2 (2, 33)=11.284, p<.0001, older adults had longer reading times compared to younger adults. There was also a main effect of focus, with F_1 (2, 53) = 30.707, p<.0001; F_2 (2, 33) = 64.419, p<.0001, participants had longer regression path times in the focused condition, followed by the anti-focused and lastly the baseline condition.

There was also an interaction between age and focus, however this was marginal by subjects; with F_1 (1, 54) = 2.417, p=.094; but significant by items F_2 (1, 34) = 6.027, p=.004. Older adults spent longer looking at the focused condition and the anti-focused condition compared to younger adults. Again, because of the differences in the number of words, character length and position, these results have to be treated with caution.

Critical region There was a main effect of age, with F_1 (2, 53) =12.583, P=.001; F_2 (2, 33)=31.220, p<.0001, older adults had longer reading times compared to younger adults. There was also a main effect of focus, with F_1 (2, 53) = 7.203, p=.002; but this

was marginal by items F2 (2, 33) = 2.509, p=.08. There were no significant interactions. Young and older adults alike had longer regression path times for the focused condition, followed by the baseline and lastly the anti-focused condition. They spent less time re-reading elements outwith the scope of focus, especially in the anti-focused condition.

Post-critical region   There was a main effect of age, with F1 (2, 53) =7.037, P=.010; F2 (2, 33)=7.771, p=.007, older adults had longer reading times compared to younger adults. There was also an interaction between age and focus but this was marginal by items F1 (1, 54)= 4.04, p=.023; F2 (1, 34)= 2.092, p=.131. Younger adults had longer regression path times in the focused condition, whereas older adults had longer regression path times in the anti-focused condition. This suggests spill-over effects from the critical region. Whereas, younger adults spent longer re-reading the focused region, older adults displayed a need to reread the anti-focused condition. This could be due to older adults needing to slow down in order and carry out the extra integration processes. There were no significant interactions and in the pre-critical region there were no effects of condition on regression path times [Fs < 1.2].

Regression in

	Context Region	Pre-critical Region	Critical region	Post-critical Region
Young Focused	32.13	5.82	20.18	16.64
Young Anti-Focused	20.19	5.77	14.04	15.92
Young Baseline	26.47	9.22	18.20	11.02
Old Focused	57.31	25.06	31.62	33.40
Old Anti-Focused	47.26	31.69	27.18	27.01
Old Baseline	54.68	30.91	30.17	32.30

Table 4.9 shows the mean number of regressions in per region for each condition.

Context region There was a main effect of age, with $F_1 (2, 53) = 33.928$, $P<.0001$; $F_2 (2, 33)=10.361$, $p<.0001$, older adults made more regressions compared to younger adults. There was also a main effect of focus, with $F_1 (2, 53) = 11.231$, $p<.0001$; $F_2 (2, 33) = 6.755$, $p=.002$, participants made more regressions into the focused condition, followed by the baseline and lastly the anti-focused condition. This is despite the fact that the anti-focused region contained more characters than the other two and the baseline region is sentence initial. There were no interactions.

Critical region There was a main effect of age, with $F_1 (2, 53) = 14.457$, $P<.0001$; $F_2 (2, 33) = 18.30$, $p<.0001$, older adults made more regressions compared to younger adults. There was also a marginal main effect of focus, with $F_1 (2, 53) = 3.053$, $p=.07$; $F_2 (2, 33) = 2.81$, $p=.064$. Participants made more regressions into the focused condition,

followed by the baseline and lastly the anti-focused condition. There was a higher

probability that a regression would be triggered into a focused region more often than to

the baseline region or anti-focused region. There were no significant interactions and in

the pre-critical and post-critical regions there were no effects of condition on regressions

[Fs < 1.2].

Is probe recognition due to a lack of encoding?

To investigate the possibility the probe recognition results is simply down to a

lack of encoding, I correlated the performance on the probe accuracy scores with the

critical regions' total time measure.

Table 4.10 shows the correlations between probe recognition accuracy and critical total

time region.

	Focus Total time	Baseline Total time	Anti-focus Total time
Young Probe Recognition	-.021	-.288	-.450*
Old Probe Recognition	-.029	-.049	-.264

*Correlation is significant at the 0.05 level

As table 4.10 shows, both young and older adults demonstrated an overall pattern

of negative correlations between probe recognition and total time. These results

produced only one significant trend in the younger age group. The correlation data

suggests that younger adults with higher total reading times in the critical region were

more capable of recognising a probe word contained within an anti-focused type

sentence. These findings suggest that the possibility that the failure to recognise a probe word is not due to a lack of encoding.

DISCUSSION

The current experiment measured whether a noun within the scope of focus will have an enhanced memory representation over a longer period of time than could be inferred from the change-detection study. Other studies have shown that focus enhances memory for terms within its scope, and also enhances priming (e.g., Birch, Albrecht & Myers, 2000; Birch & Garnsey, 1995; Birch & Rayner, 1997). The issue as to how focus affects eye movement patterns is less clear. In Birch and Rayner's (1997) eye tracking study, they found that readers spent longer on the focused word rather than the non-focused words. In contrast, Morris and Folk (1998) found that reading times were actually shorter for focused than for non-focused words, this they took to indicate that focused information was easier to integrate into the discourse representation than non-focused information.

In the present study, late probes were much more readily recognised, and participants' showed reduced reaction times, when they were made to elements within the scope of focus than when they were outside the scope of focus. When the key element was within the scope of focus, for both age groups recognition rates were increased and reaction times reduced, relative to baseline. Older adults displayed poorer recognition rates when words were in the baseline condition compared to younger adults, showing that focus was effectively more advantageous, in performance terms, for the older group than for the young. The opposite was the case when the anaphoric referent was outside

the scope of focus, for both age groups recognition rates were decreased and reaction times increased, relative to baseline. The pattern of suppression was much larger in the older age group compared to younger adults. Taken together with the results of Experiment 3, these findings confirm focus induced memory enhancement, and extend finding through the consistent demonstration of suppression effects. They confirm that the effects are relatively greater in the older group.

The principal results from the eye movement record were found with reading times in the critical region, where the probe word occurred. The Total time measure showed that both age groups spent longer on the critical region in the focused condition, followed by the baseline, and finally by the anti-focused condition. For the critical region, there were more regression out for the focused condition, followed by the control, and finally by the anti-focused condition. The same pattern occurred for regressions into the critical region, as well as into earlier regions. All-in-all, this pattern of results shows that information structuring brings about reading pattern differences. These findings are in line with one previous investigation (Birch & Rayner, 1997) that found focused concepts lead to longer reading times, and are contrary to the findings of Morris and Folk (1998).

Importantly here, the effect of focus cues on the elderly show no differences from those in the young in eye-tracking, so it is unlikely that more cautious and structured eye-based encoding by the elderly explains equal or exaggerated performance effects that were shown in earlier experiments, and that appear in the probe data. To investigate the possibility the probe recognition results is due to a lack of encoding, I correlated the performance on the probe accuracy scores with the critical regions' total time measure.

The overall lack of a relationship between probe accuracy and total time measure suggests that the possibility that the failure to recognise a probe word is not due to a lack of encoding for both young and older adults.

Taken together with the work in the previous chapter, it is manifest that information structuring in both written and spoken modes influences the deployment of processing in the elderly just as much as it does in the young. It affects patterns of eye-movements in reading, it affects anaphoric integration, and it affects memory representation. In many instances, both enhancement effects of focus, and suppression effects on anti-focus show somewhat exaggerated effects in the elderly. The significance of this will be addressed in the general discussion chapter. In the next chapter, I examine another rather different cue as to the "importance" of aspects of text, that are related in different ways to the information structuring studies examined to date. The questions remain the same: are there age-related differences in using these cues?

CHAPTER 5: THE INFLUENCE OF CLAUSE STATUS

INTRODUCTION

The current experiments manipulated subordination (which is related to focus), to investigate the effect this established cue has on the older sample (See Chapter 2 for a full review). The current studies aimed to replicate previous findings by Cooreman and Sanford (1996) that suggests differential processing of main and subordinate clauses. Previous studies (using a probe recognition task) have found the order of which the two clauses appear has an impact, individuals mentioned first tended to be recognised faster than individuals mentioned second (e.g., Gernsbacher & Hargreaves, 1988; 1992; Gernsbacher, Hargreaves & Beeman, 1989). The present studies sought to clarify this issue in greater detail to see whether the pattern of results fits with Cooreman and Sanford's findings or that of Gernsbacher and her colleagues.

This chapter follows the same pattern of chapter 3; however, the change blindness task has been replaced by the delayed probe recognition task. Experiment 5, using a sentence continuation task, investigated the effect of main versus subordinate clauses type sentences to check whether a bias towards main clauses is present in the older sample. Experiment 6, using a self-paced reading task, investigated whether when a character is mentioned in either a main or subordinate clause affects processing a subsequent anaphoric target sentence which would either mention the main or subordinate character.

In experiment 7, I examined whether a key element contained in a main clause is more available even after a delay than concepts introduced within a subordinate clause. Are subordination effects due to encoding (tested through eye-movements') and finally, is there an age differential?

EXPERIMENT 5

Method

Design and Materials

Experimental materials were devised in which two characters were portrayed as interacting in a social scene. There were 24 experimental materials in four different scripts each containing 6 items based on those used by Cooreman and Sanford (1996). An example of each type of material is given in the table 5.1 below.

Table 5.1 Examples of the type of experimental materials used.

Main-subordinate	Subordinate-main
John booked the cinema tickets after Mary finished work.	After Mary finished work John booked the cinema tickets.
John booked the cinema before Mary finished work.	Before Mary finished work John booked the cinema tickets.

The 24 experimental items were assigned to the files so that equal numbers of each condition appeared on each file, with only one version of each item appearing on each file, so that participants did not see more than one version of any given item. By rotation, all materials appeared in all conditions over the four files.

Participants

24 younger adults (mean age = 23, 16 women, 8 men) with an age range of 18 to 30 years old and 24 healthy older adults (mean age = 77, 19 women, 5 Men) with an age

range of 65 to 90 years old from the Glasgow University community participated in the study. Older participants were reimbursed any transportation expenses. All were native English speakers of English.

Participants were required to complete the National Adult Reading Test (Nelson, 1982). This was done in order to gauge basic intelligence level of all the participants. Demographic information such as occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was slightly but significantly higher for older adults (mean predicted I.Q = 118.63, S.D = 4.15) than younger adults (mean predicted I.Q = 116.08, S.D = 3.32), t (46) = 2.34, p = .024). The mean score of the participants years of education was significantly higher for younger adults (mean years of education = 17.54, S.D = 2.15) than older adults (mean years of education = 12.08, S.D = 3.97), t (46) = 5.91, p< .0001).

Procedure

Experimental procedures were identical to those described in Experiment 1 in chapter 3.

Results and discussion

Data Treatment for statistical analysis

The frequencies of responding with continuations to the main or the subordinate clauses were used as the basis of data for inferential statistics based on log-linear

modelling (for a fuller description see experiment 1, chapter 3). The following equation was used to characterise biases towards responding with a main-based or subordinate-based continuation:

$$\text{LOGIT (MAIN)} = \log \frac{p(\text{Main})}{p(\text{Sub})}$$

A value above zero indicates a bias towards producing a sentence continuation referring to the main clause rather than the subordinate clause of a sentence. Sentence completions were coded as either 'classifiable' (i.e. the sentence contained a clear reference to either the main or the subordinate clause) or 'unclassifiable' (i.e. the sentence was ungrammatical or could not be classed). All trials where the sentence completions were classified as 'unclassifiable' were excluded from further analysis (this accounted for only 1.5 % of the data).

Loglinear analysis was carried out on the logit values by participants (F1) and items (F2) treating age (young vs. old) as a between subject factor, clause status (main vs. subordinate) and clausal order (main-subordinate vs. subordinate-main) were treated as the within-participant and within-item factors.
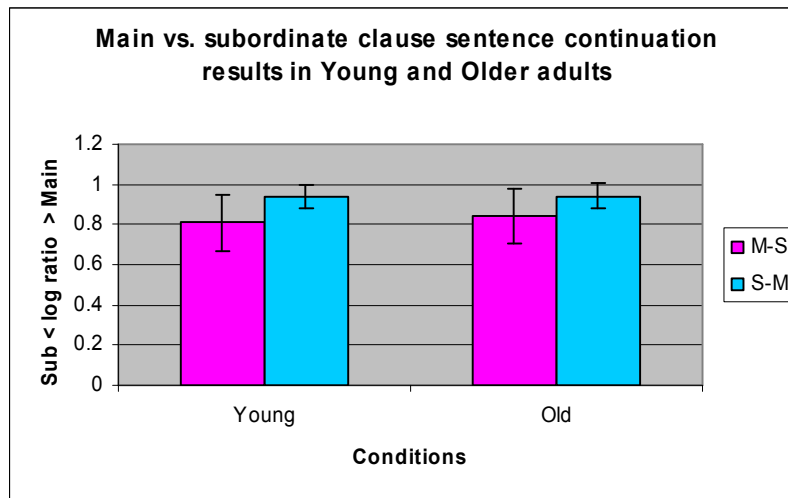
Figure 5.1 show the mean log ratio sentence continuations and standard errors for the clausal order conditions at each age level.

It is clear from figure 5.1 that both age groups show a strong bias towards producing a continuation which refers to the main clause of a sentence. It also appears that regardless of clausal order, clause status is the only factor controlling the pattern of sentence continuations. Furthermore, participants in both age groups appear more likely to produce main clause continuations. This effect is highly reliable, with $F1(1, 46) = 39.229$, $p<.0001$; $F2(1, 22) = 32.443$, $p<.0001$. There was no effect of age $F1 (1, 46) = .059$, $p = .809$; $F2 (1, 22) = .109$ $p = .743$, no effect of clausal order $F1 (, 46) = .432$, $p = .587$; $F2 (1, 22) = .629$, $p = .617$. No clausal order/age interaction was found $F1 (1, 46) = .329$ $p = .569$; $F2 (1, 22) = .511$ $p = .478$.

These results showed that both age groups had an overwhelming bias towards producing sentences that referred to the main clause of a sentence. It seems that main clauses are given more prominence in subsequent processing than are subordinate clauses. The information contained in main clause of a sentence is more available than

information contained in a less prominent position. The order in which the clauses were presented did not appear to affect the pattern of the results. All of this is consistent with the findings of Cooreman and Sanford (1996). The pattern of results shows no differentiation between young and older adults across all conditions presented here, and that the older sample is as sensitive to the main/subordinate cue as the younger sample.

EXPERIMENT 6

In this experiment, I examined the influence of the main/subordinate cue on processing sentences containing anaphoric references. I would predict that subjects' average reading times should be faster when the target sentence is coherent with the main clause rather than the subordinate clause. The question is whether there are any age differences in the pattern of processing.

Method

Design and Materials

This study used a 2x2x2 mixed factor design with clause type (main vs. subordinate), the order of clause (Main-subordinate vs. Subordinate-Main) and age (young vs. old) being the independent variables. Sentences were devised in which two characters (one male and one female) were portrayed as interacting in a social scene. Of the names used, half were stereotypically female and half were stereotypically male. The first sentence either included a main clause, followed by a subordinate clause (order

Main-Sub), or the first sentence contained a subordinate clause followed by a main clause (order Sub-Main).

The final (target) sentence contained a sentence-initial anaphoric pronoun to either the character in the main clause or the character in the subordinate clause, and was consistent with what might be expected of that character. There were 32 experimental materials in four different scripts each containing 8 items based on those used by Cooreman & Sanford (1996). An example of each type of material is given in the table 5.2 below. The pronouns referring to the main clause are highlighted in **bold** whereas the pronouns referring to the subordinate clause are highlighted in *italic* for illustration purposes only and did not appear during the experiment.

Clausal Order	Main-Sub-**Main** OR *Sub*	Sub-Main-**Main** OR *Sub*
Test sentence	John booked the cinema tickets after Mary finished work.	After Mary finished work, John booked the cinema tickets.
Target Sentence	**He**/*she* wanted to see the new western.	**He**/*she* wanted to see the new western.
Question	Did John buy theatre tickets?	

Table 5.2 – Antecedent sentence types and target sentences either consistent with the main clause or subordinate clause.

This enabled me to investigate the impact of clausal order and clausal status on anaphoric resolution. This was then followed by a comprehension question that either

referred to the main clause or to the subordinate clause in order to check that participants

were reading the sentences for the sake of comprehension. Half of the questions were

designed to give a Yes answer and other half were designed to give a No answer.

Each file contained one of the four possible versions of each item, but overall

contained an equal number of all conditions, and so that participants did not see more

than one version of any given item.   In addition to this there were 64 filler materials

from an unrelated experiment. There were thus 4 conditions in all: 2 (antecedent

sentence type) x 2 (anaphor referring to main clause or subordinate clause).

Participants

32 younger adults (mean age = 21, 20 women, 12 men) with an age range of 18 to

28 years old and 32 healthy older adults (mean age = 71, 20 women, 12 Men) with an age

range of 65 to 92 years old from the Glasgow University community took part in the

experiment. Older participants were reimbursed any transportation expenses. All were

native English speakers of English. The sample of participants did not take part in the

previous experiment.

Participants were also required to complete the National Adult Reading Test

(Nelson, 1982). This was done in order to gauge basic intelligence level of all the

participants. Demographic information such as occupation, age and number of years in

education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982)

was significantly higher for older adults (mean predicted I.Q = 116.97, S.D = 8.487) than

younger adults (mean predicted I.Q = 112.32, S.D = 6.19), $t(62) = 5.129$, $p = .001$). The

mean score of the participants years of education was significantly higher for younger

adults (mean years of education = 17.5, S.D =1.47) than older adults (mean years of

education =12.34, S.D =2.32), t (62) = 4.439, p=.001).

Procedure

Experimental procedures were identical to those described in Experiment 2 in

chapter 3.

Results

Question Accuracy

There was a high proportion of correct answers to the comprehension questions

on the critical materials (see table 5.3) and none of these numerical differences were

statistically reliable.

Table 5.3 – Antecedent sentence types and the percentage of correct answers at each age

level.

	Percentage correct for main clause condition	Percentage correct for subordinate clause condition
Young	92.2%	89.1%
Old	93.6%	89.3%

Reading time

The target sentence reading time data is shown in figure 5.2. ANOVAs were computed for participants (F1) and items (F2).

It is clear from figure 5.2, while older adults had overall longer reading times than younger adults, the pattern of results is similar for both age groups. Participants appear to show reduced reading times when the target sentence referred to the main clause rather than the subordinate clause of a sentence. Irrespective of the order of mention, participants also appear to respond faster to the target sentence referring to the main clause rather than the subordinate clause. It also seems that older adults display a sharper increase in processing time compared to younger adults when the target sentence is consistent with the subordinate clause of the sentence.
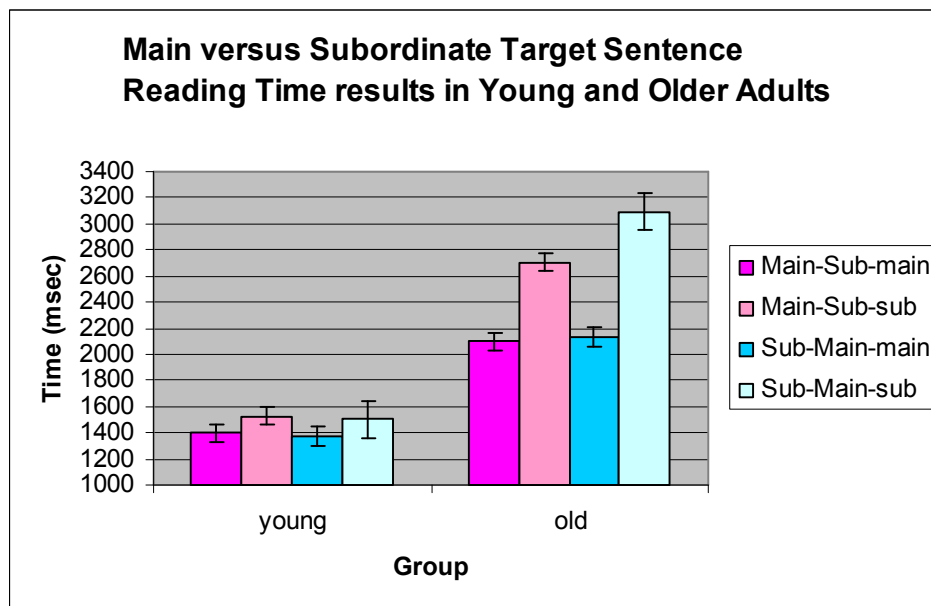
Figure 5.2 shows the mean target sentence reading times and standard errors for the clausal order, and clause type conditions at each age level.

There was a main effect of age; older adults had significantly longer reading times than younger adults, with $F1 (1, 62) = 21.848$, $p<.0001$; $F2 (1, 30) = 95.825$, $p<.0001$. The analysis shows that across conditions and groups, there is a significant effect of probe; with $F1 (1, 62) = 16.235$, $p <.0001$; $F2 (1, 30) = 8.310$, $p=.005$. Participants were significantly more likely to respond faster to the target sentence referring to the main clause than the subordinate clause.

There was an interaction between age and clause status with older adults, with $F1 (1, 62) = 8.144$, $p=.006$; however it was marginal by $F2 (1, 30) = 3.494$, $p=.079$. So, while both younger and older adults had reduced processing times when the target sentence referred to the main clause, older adults displayed a sharper increase in processing time when the target sentence referred to the subordinate clause compared to younger adults. Main clauses facilitated the integration of an anaphoric sentence for both age groups, when the target sentence referred to the subordinate clause it clearly disrupted processing to a much greater extent in the older age group.

There was no effect of clausal order; with $F1 (1, 62) = .486$, $p = .488$; $F2 (1, 30) = 1.197$, $p = .278$, no interaction between clause order/Age, with $F1 (1, 62) = .824$, $p = .368$; $F2 (1, 30) = .197$, $p = .659$, no clausal order/clause status, with $F1 (1, 62) = .615$, $p = .436$; $F2 (1, 30) = .113$, $p = .738$, and no clausal order/clause status/Age interaction, with $F1 (1, 62) = .572$, $p = .452$; $F2 (1, 30) = .146$, $p = .703$.

These results show that sentences containing anaphoric references to main clauses are processed more easily, that this is true of old and young groups, and that there is marginal evidence for a greater impact of reference to subordinate sentences in the older sample. This is broadly consistent with what was found for the cleft studies. Thus both

direct cueing of focus through clefting, and indirect cueing through a connective-driven main/subordinate clause distinction work well for both age groups.

In the next experiment, I examined two things. Whether a noun-phrase introduced within a main clause is more available after a delay than a noun-phrase introduced within a subordinate clause. Are subordination effects due to encoding (tested through eye-movements) and finally, is there an age differential?

EXPERIMENT 7

In the present study, I was interested to see whether subordination, even after a delay, will affect the distinctiveness of elements in memory. Also, I was concerned to see whether the subordination effects result from difference in encoding, indexed through eye-tracking. For instance, it is possible that the strong clause status effects in the elderly result from disproportionately longer times being spent reading material contained in the main clause.

Participants read a block of sentences while their eye movements were monitored. They then performed a delayed speeded recognition tests on the target words for the sentences in that block. I would predict that probe recognition in the subordinate will be less than that found in the main clause.

Method

Participants

28 younger adults (mean age =21.5, 17 women, 11 men) with an age range of 18 to 31 years old and 28 healthy older adults (mean age =70.5, 18 women, 10 Men) with an age range of 61 to 86 years old from the Glasgow University community took part in the experiment and were each paid £6. Older participants were also reimbursed any transportation expenses. All were native English speakers with normal or corrected-to-normal vision. The sample of participants did not take part in the previous experiment.

Participants were required to complete the National Adult Reading Test (Nelson, 1982). This was done in order to gauge basic intelligence level of all the participants. Demographic information such as occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was significantly higher for older adults (mean predicted I.Q =118.43, S.D =3.33) than younger adults (mean predicted I.Q = 113.14, S.D =2.92), t (54) = 6.29, p<.0001). The mean score on the Wechsler Adult Intelligence digit span test (WAIS-III) was slightly but significantly higher for younger adults (mean digit span = 19.36, S.D =.82) than older adults (mean digit span =17.93, S.D =1.90), t (54) = 3.64, p=.001).[4] The mean score of the participants years of education was not significantly higher for younger adults (mean years of education = 16.29, S.D =2.74) than older adults (mean years of education =15.04, S.D =3.56), t (54) = 1.47, p=.147).

Materials and Design

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[4] Correlations between digit span and probe recognition accuracy produced no significant trends and are given in appendix three.

The design of this study was a 2x2x2 repeated measures design to investigate the effects of clause status (main vs. subordinate); clausal order (Main-subordinate vs. subordinate-main) and age (young vs. older) while measuring participants' eye movements, probe recognition and probe reaction time. The basic design is aimed at comparing the eye- tracking record, probe accuracy and reaction time in response to *tickets* or *dishes* under the main and subordinate conditions with each other.

Modified versions of the thirty-two experimental materials used in Experiment 4, plus four new items, were used. Examples of experimental items are shown in Table 5.4. The first sentence was a context sentence introducing the scene with no emphasis on events occurring in either clause. The critical sentence either included a main clause, followed by a subordinate clause (order Main-Sub), or the critical sentence contained a subordinate clause followed by a main clause (order Sub-Main). Note that the final sentence in this case does not contain a sentence-initial anaphoric pronoun to either the character in the main clause or the character in the subordinate clause. Probe words contained either in the main or subordinate clause of critical sentence was displayed after participants finished reading a block of passages.

Word frequency and length might also influence the likelihood of recognising a probe; the critical nouns were matched across conditions for length, and for frequency using the British National Corpus (900 million words) and no significant differences were found. The mean log frequencies of occurrence per million were: main clause = 3.21 (.14), subordinate clause = 3.11 (.16). The length of the nouns in the main clause conditions averaged 5.56 (min.= 4, max.= 9) characters, while the nouns in the subordinate clause condition averaged 5.45 (min.= 4, max.= 9) characters. Hence, any

difference in reading times between conditions will not to be due to discrepancies in length or frequency of the nouns.

One version of each item was assigned to one of two files. The 36 experimental items were assigned to the files so that equal numbers of each condition appeared in each file, with one version of each item appearing in each file, and so that participants did not see more than one version of any given item. The items were displayed with one hundred and eight filler passages and probes from an unrelated experiment. At least one filler item intervened between each experimental item.

Clausal Order	Main-Sub	Sub-Main
Test Material	The two lovers had been living together for nearly a year. John booked the cinema tickets that |night after Mary finished doing the dishes quickly. They wanted to see the new western.	The two lovers had been living together for nearly a year. After Mary finished doing the dishes quickly; John booked the cinema tickets that night. They wanted to see the new western.
Probe Word	Main clause - Tickets	Subordinate clause - Dishes

Table 5.4 – Example of text passages followed by the probe word contained in either the main or subordinate clause.

Procedure

The probe recognition task, eye tracking and experimental procedures were identical to those in described in chapter 4 (experiment 4).

RESULTS

Probe Accuracy Results

As can be seen from table 5.5, both young and older adults recognised more probe words when they were contained in the main clause, with least being recognised in the subordinate clause, irrespective of the order of mention. It also seems that older adults display a sharper decrease in probe recognition compared to younger adults when the probe word is contained in the subordinate clause of the sentence.

Table 5.5 Mean percentage correct detections for probes, with standard errors.

	Main-Sub Main probe	Main-sub Sub probe	Sub-Main Main probe	Sub-Main Sub probe
young	60.33 (1.62)	54 (1.64)	61.89 (1.95)	51.56 (1.52)
old	69.44 (1.63)	46.78 (1.42)	68.67 (1.31)	50.44 (1.32)

ANOVAs were computed by participants (F1) and items (F2) on the accuracy data. There was no main effect of age, with $F1_{(1, 54)}=.399$, P=.530; $F2_{(1, 34)}=2.59$, p=.112. There was a main effect of clause status, with $F1_{(1, 54)} = 38.318$, p<.0001; $F2_{(1, 34)} = 25.854$, p<.0001. Participants recognised more probe words contained in the main clause of a sentence compared to the subordinate clause.

Importantly, there was also an interaction between age and clause status; with F1 (1, 54)=6.781, p=.012; F2 (1, 34)=6.594, p=.012. Older adults not only recognised more probe words contained in the main clause, they also had a sharper decline in probe recognition when the probe words were contained in subordinate clause compared to younger adults.

Reaction Time to Probe

Table 5.6 Mean target recognition time and standard error.

	Main-Sub Main RT	Main-sub Sub RT	Sub-Main Main RT	Sub-Main Sub RT
Young	1409 (348)	1529 (483)	1196 (332)	1542 (441)
Old	1786 (401)	2269 (714)	1774 (486)	2045 (594)

As can be seen from table 5.6, both young and older adults seem to respond faster when the probe words were contained in the main clause, with longer reaction to probe times for words contained in the subordinate clause.

2x2 ANOVAs were carried out by participants (F1) and items (F2). There was a main effect of age, with F1 (1, 54)=50.76, P<.0001; F2 (1, 34)=57.826, p<.0001, older adults had longer reaction times compared to younger adults. There was a main effect of clause status, with F1 (1, 54) = 41.587, p<.0001; F2 (1, 34) = 36.064, p<.0001. Participants had reduced reaction time to probe words contained in main clause compared to the subordinate clause. There was also an interaction between Status x Age, with F1

(1, 54)=5.04, p=.029; F2 (1, 34)=6.495, p=.013. Older adults had increased reaction time to probe words contained in the subordinate clause compared to younger adults.

Regions of analysis The first and last sentences were treated as whole regions (introduction and end regions) and because these regions were so large and only served the purpose of setting the context and finishing the story, the data from these regions will not be reported. The critical second sentence was divided into two regions for the purpose of aggregating reading times and classifying eye- movements, as shown in (5.8). Both regions contained the same number of words in the two versions and approximately the same number of characters.

Main-Subordinate	Subordinate-Main
John booked the cinema| tickets that[1] |night after Mary finished doing| the dishes [2]|quickly.	After Mary finished doing| the dishes[1] |quickly; John booked the cinema |tickets that [2]|night.

Table 5.7 Examples of each sentence type divided into the critical regions.

Regions 1 and 2 (critical) always consisted of the main clause or subordinate clause noun, plus *the* or *that* and thus this region was always two words long. First-pass reading time, First-pass regressions out, regression path time, total reading time and regressions in measures were used to analyse tracking patterns. See Chapter 4, Experiment 4 for full details of these measures of analysis. Prior to analysis, fixations

were pooled, truncated or removed if necessary (see Chapter 4 for details of this procedure), which accounted for less than 2% of the data.

First pass reading times

	Main-Sub Main Region 1	Main-Sub Sub Region 2	Sub-Main Main Region 2	Sub-Main Sub Region 1
Young	278.38	295.07	297.32	301.88
Old	296.33	358.74	335.18	444.87

Table 5.8 Mean first-pass reading times per region for each condition at each age level.

There was a main effect of age, with F1 (1, 54) =4.683, p =.035; F2(1,34)=7.127, p=.009. Older adults had longer first pass reading times compared to younger adults. There was also a main effect of status, with F1 (1, 54) = 11.51, p=.001; F2 (1, 34) = 5.74, p=.02, participants spent longer looking at the subordinate clause condition compared to the main clause condition. There was also an interaction between Clause Status x Age, with F1 (1, 54)=5.837, p=.019; but this was marginal by items, with F2 (1, 34)=3.025, p=.086. Older adults had increased first pass reading times in the subordinate clause condition compared to younger adults.

Total reading time

Table 5.9 Mean total reading times per region for each condition at each age level.

	Main-Sub Main Region 1	Main-Sub Sub Region 2	Sub-Main Main Region 2	Sub-Main Sub Region 1
Young	339.90	360.79	366.59	373.44
Old	461.18	486.68	501.60	546.81

There was a main effect of age, with F1 (1, 54) =22.353, P<.0001; F2 (1, 34) = 38.834, p<.0001, older adults had longer total reading times compared to younger adults. There was also a main effect of status, with F1 (1, 54) = 7.018, p=.011; F2 (1, 34) = 4.123, p=.047, participants spent longer looking at the subordinate clause condition compared to the main clause condition. There was also an interaction between Status x Age, with F1 (1, 54)=3.965, p=.05; but this was marginal by items, F2 (1, 34)=2.969, p=.091, older adults had increased total reading times in the subordinate clause condition compared to younger adults.

Regression out

	Main-Sub Main Region 1	Main-Sub Sub Region 2	Sub-Main Main Region 2	Sub-Main Sub Region 1
Young	24.16	21.93	21.96	25.20
Old	27.03	23.45	23.33	29.95

Table 5.10 shows the mean number of regressions out per region for each condition at each age level.

There was a main effect of age, with F1 (1, 54) =5.903, P=.018; F2 (1, 34) =8.393, p=.005. Older adults made more regressions compared to younger adults. There was also an interaction between order x clause, with F1 (1, 54) =4.155, p=.046; F2 (1, 34) =5.001, p=.029. There was a higher probability that a regression would be triggered out of the initial region regardless of the clausal order or clause status.

Regression path

	Main-Sub Main Region 1	Main-Sub Sub Region 2	Sub-Main Main Region 2	Sub-Main Sub Region 1
Young	509.30	618.76	543.68	695.41
Old	571.07	716.66	598.50	705.33

Table 5.11 shows the mean regression path times per region for each condition at each age level.

There was a main effect of age, with F1 (1, 54) =4.885, P=.031; F2 (1, 34)=4.624, p=.036, older adults had longer reading times compared to younger adults. There was also a main effect of clause status, with F1 (1, 54) = 15.995, p<.0001; F2 (1, 34) = 7.439, p=.009, participants had longer regression path times in the subordinate clause condition compared to the main clause condition. They spent less time re-reading elements contained in the main clause.

Regression in

	Main-Sub Main Region 1	Main-Sub Sub Region 2	Sub-Main Main Region 2	Sub-Main Sub Region 1
Young	15.72	4.59	4.38	10.69
Old	28.10	7.40	8.93	23.48

Table 5.12 shows the mean number of regressions in per region for each condition at each age level.

There was a main effect of age, with $F1_{(1, 54)}$ = 23.603, P<.0001; $F2_{(1, 34)}$ = 28.603, p<.0001; older adults made more regressions compared to younger adults. There was also an interaction between order x clause, with $F1_{(1, 54)}$ =86.283, p<.0001; $F2_{(1, 34)}$= 99.679, p<.0001. There was a higher probability that a regression would be triggered into the initial region regardless of the clausal order or clause status. This result indicates both young and older adults were more likely to reread an earlier portion of a sentence.

Is probe recognition accuracy due to a lack of encoding?

To investigate the possibility the probe recognition results is due to a lack of encoding, I correlated the performance on the probe accuracy scores with the critical regions' total time measure. As table 5.13 shows, both young and older adults demonstrated a mixed pattern of negative and positive relationship between probe recognition and total time.

Table 5.13 shows the correlations between probe recognition accuracy and critical total time region.

	Main-sub-main Probe Recognition	Main-sub-sub Probe Recognition	Sub-main-main Probe Recognition	Sub-main-sub Probe Recognition
Young Probe Recognition	-.334	-.048	-.150	.143
Old Probe Recognition	.404*	.079	-.001	.262

*Correlation is significant at the 0.05 level

These results produced only one significant trend in the older age group. The correlation data suggests that older adults with higher total times were more capable of recognising a main clause probe word contained within the main-subordinate clausal order. These findings suggest that the possibility that the failure to recognise a probe word is not due to a lack of encoding.

DISCUSSION

The current experiment aimed at testing whether probe recognition is adversely affected after a delay when a word is contained in the main clause of a sentence, and how such an effect might be modulated by ageing. Probe words were much more readily recognised when they were contained in the main clause of a sentence rather than the subordinate clause. Older adults also displayed a sharper drop in recognition rates when words were in the subordinate condition compared to younger adults. The eye-tracking results showed that the failure to detect subordinate clause memory probes is not due to a

lack of encoding, as participants had overall reading time in the subordinate clause condition compared to the main clause condition.   The current experiment suggests that even after a delay, clause status has an impact on the memory strength of a noun phrase.

GENERAL DISCUSSION

Existing evidence showed that main clauses of complex sentence are given more prominence in subsequent processing than are subordinate clauses (e.g., Cooreman & Sanford, 1996). The results of this study provide insight into whether older adults are as sensitive to the cue as younger adults. In the sentence continuation study (Experiment 5), I showed that both age groups were more likely to produce sentences referring to the main clause rather than the subordinate clause of the sentence. This shows apparently equally responsiveness to the subordination cue.

In the reading time study (Experiment 6), I showed that information contained in the main clause led to faster self-paced reading times compared to the subordinate clause and this pattern of results was exaggerated in the older sample. Contrary to the findings of Gernsbacher and her colleagues, information contained in the main clause of the sentence rather than the subordinate clause was much more available for both age groups **regardless of clausal order**. Older adults showed a larger effect of clause status, in terms of reading times, than did their younger counterparts. So, while off-line data indicates that older people are just as influenced by clause status, as are younger people, in terms of speed of processing, the effects are much greater. For both age groups, a main clause facilitated the integration of an anaphoric sentence, which can be clearly seen

by the reduced processing times. However, a subordinate clause disrupted the integration of an anaphoric sentence which can be clearly seen by the increased processing times especially in the older age group.

Experiment 7, using a delayed probe recognition task, I found that both younger and older adults recognised more probe words contained in the main clause of a sentence compared to the subordinate clause. This contradicts previous findings, where characters mentioned first are more available after a delay (e.g., Gernsbacher & Hargreaves, 1988; Gernsbacher, Hargreaves & Beeman, 1989). The pattern of results I obtained replicate and extended the previous findings by Cooreman and Sanford (1996). In the present study, late probes were much more readily recognised, and participants' showed reduced reaction times, when they were made to elements contained in the main clause than when they were contained in the subordinate clause of a sentence, irrespective of clausal order. Older adults displayed poorer recognition rates when words were contained in the subordinate clause compared to younger adults, and better recognition rates when the words were contained in the main clause therefore, effectively more advantageous, in performance terms, for the older group than for the young.

The issue as to how clause status affects eye movement patterns is less clear. As far as I am aware there is no existing work on this issue. The first pass, total time and regression path reading measures showed that both age groups spent longer looking at the subordinate clause region than the main clause region. There were more regressions out of the initial region regardless of the clausal order or clause status. The same pattern also occurred for regressions into the initial region. This pattern of results shows that information structuring brings about reading pattern differences. It also ruled out the

possibility that the failure to detect subordinate clause memory probes is due to a lack of encoding, as this would predict lower overall reading time on the subordinate clause region.

These findings are in line with one previous investigation on a related issue by Morris and Folk (1998) that found that reading times were actually shorter for focused than for non-focused words, this they took to indicate that focused information was easier to integrate into the discourse representation than non-focused information. Unlike the findings of another similar eye tracking study by Birch and Rayner (1997) which found readers spent longer on the focused word rather than the non-focused words.

Both age groups were sensitive to the main/subordinate distinction, as measured by the sentence continuation, self-paced reading and probe recognition tasks. The present studies suggest both young and older adults integrate with ease information contained in the main clause rather than information contained in the subordinate clause of a sentence. In many instances, there were exaggerated effects in the elderly. Taken together with the work in the previous chapters (3 & 4), it is clear that information structuring influences the deployment of processing in the elderly just as much as it does in the young. It affects patterns of eye-movements in reading, it affects anaphoric integration, and it affects memory representation.

The significance of this will be addressed in the general discussion chapter. In the next chapter, I examined another 'attention capturing' device that is related to the information structuring studies examined so far. The questions remain the same: are there age-related differences in using this cue?

CHAPTER 6 –PROPER NAMES AS A CONTROLLER OF PROMINENCE AND

PROCESSING

INTRODUCTION

The current experiments used the proper name/role contrast, where proper names provide a cue as to which is the "main character" in short two-person vignettes, as reviewed in Chapter 2 . The current studies attempted to replicate previous findings by Sanford, Moar and Garrod (1988) that it was only the type of description (a proper name or a role description) that influenced the subject of the continuation sentence. They also found in a self-paced reading task that named characters lead to reduced processing times than a character described by a role. Previous studies by Gernsbacher and her colleagues (using a probe recognition task) have found it is simply individuals mentioned first character tended to be recognised faster than individuals mentioned second. The present studies sought to clarify this issue in greater detail to see whether the pattern of results fits with Sanford, Moar and Garrod's findings or those of Gernsbacher and her colleagues using a probe method.

The current chapter follows the same pattern of the previous chapter; Experiment 8 investigated the effect of a proper name versus role descriptions on sentence continuations to establish a whether there is a bias towards named characters in the older sample. Experiment 9, using a self-paced reading task, investigated whether when a character is mentioned in either a main or subordinate clause affects processing a subsequent anaphoric target sentence which would either refer to the named character or role description. In experiment 10, I examined whether a proper name is available after a delay compared to a role description. Also, I answer the question of whether the proper name/role contrast is due to encoding (tested through eye-movements) and finally, is there an age differential for any effects found?

EXPERIMENT 8

Method

Design and Materials

The experimental materials were devised in which two characters were portrayed as interacting in a social scene. There were 24 experimental materials in two different files each containing 12 items, based on those used by Sanford, Moar & Garrod (1988). An example of each type of material is given in the table 6.1 below.

Table 6.1 – Examples of the type of experimental materials used.

Name-Role	Role-Name
Mr Branson was dictating a letter. The secretary was taking shorthand.	The Manager was dictating a letter. Jane was taking shorthand.

The first sentence included a proper name followed by another sentence containing a role. Or the initial sentence contained a role followed by another sentence containing a proper name. But within each sentence, the name or role was stereotypical of different genders. Of the proper names used, half were stereotypically female and half were stereotypically male. The descriptions used were designed so that the roles would appear as unambiguous as possible and different with respect to gender. One of the characters might be expected by default to be male (e.g., Manager), then the other was arranged to be expected by default to be female (e.g., Secretary). This was assessed by

pre-testing for gender differences on a scale of 0 (typically male) to 7 (typically female).

Five participants rated the perceived gender differences between the role descriptions

(typical male mean = 1.8, typical female mean = 4.8).[5]

I generated Name → Role, Role → Name configurations, providing a basis for

testing the impact of order of mention and character description on the likelihood of

forming a continuation referring to a given character. The 24 experimental items were

assigned to the files so that equal numbers of each condition appeared on each file, with

only one version of each item appearing on each file, so that participants did not see more

than one version of any given item. By rotation, all materials appeared in all conditions

over the two files.

Participants

24 younger adults (mean age = 23, 16 women, 8 men) with an age range of 18 to

30 years old and 24 healthy older adults (mean age = 77, 19 women, 5 Men) with an age

range of 65 to 90 years old from the Glasgow University community participated in the

study. Older participants were reimbursed any transportation expenses. All were native

English speakers of English.

Participants were required to complete the National Adult Reading Test (Nelson,

1982). This was done in order to gauge basic intelligence level of all the participants.

Demographic information such as occupation, age and number of years in education was

also asked as well as any pertinent medical information.

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[5] The ratings for each role description is given in appendix two.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was significantly higher for older adults (mean predicted I.Q = 118.63, S.D = 4.15) than younger adults (mean predicted I.Q = 116.08, S.D = 3.32), t (46) = 2.34, p = .024). The mean score of the participants years of education was significantly higher for younger adults (mean years of education = 17.54, S.D = 2.15) than older adults (mean years of education = 12.08, S.D = 3.97), t (46) = 5.91, p< .0001).

Procedure

Experimental procedures were identical to those described in Experiment 1 (chapter 3).

Results and discussion

Data Treatment for statistical analysis

The frequencies of responding with continuations to the main or the subordinate clauses were used as the basis of data for inferential statistics based on log-linear modelling (for a fuller description see experiment 1, chapter 3). The following equation was used to characterise biases towards responding with a name-based or a role-based continuation:

$$\text{LOGIT (NAME)} = \log \frac{p(\text{Name})}{p(\text{Role})}$$

Sentence completions were coded as either 'classifiable' (i.e. the sentence clearly referred to a proper name or a role) or 'unclassifiable' (i.e. the sentence was incomplete, ungrammatical, used a plural pronoun, or could not be classed). All trials where the sentence completions were classified as 'unclassifiable' were excluded from further analysis (this accounted for only 14.7% of the data). A log linear analysis was carried out on the logit values by participants (F1) and items (F2) treating age (young vs. old) as the between subject factor, Order of mention (name-role vs. role-name) and target completion (Name vs. role) were treated as the within-participant and within-item factors.

<figure>
Proper name vs role descriptor sentence continuation results in Young and Older adults

Legend: N-R, R-N

X-axis: Conditions (young, old)
Y-axis: Role < log ratio > Name (0 to 1.2)
</figure>
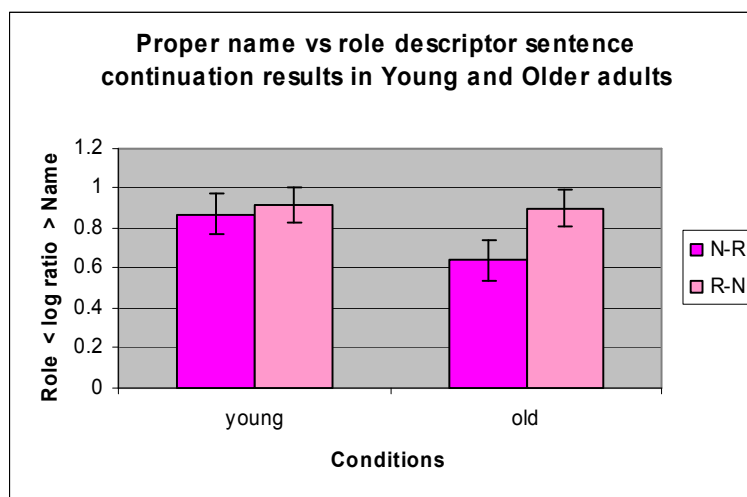
Figure 6.1 shows the mean log ratio sentence continuations and standard errors for the name-role and role-name conditions at each age level.

It is clear from figure 6.1 that both age groups show a strong bias towards producing a continuation which refers to the named character. It also appears that a named character is influencing the choice of sentence continuations rather than the order

in which the characters are mentioned. Furthermore, participants in both age groups

appear more likely to produce named character continuations. This bias was reliable,

with $F_1 (1, 46) = 6.363$, p = .015; $F_2 (1,22) = 6.10$, p = .018. The analysis showed there

was no effect of age $F_1 (1, 46) = 2.605$, p = .113; $F_2 (1, 22) = 2.89$, p = .153, and no

effect of order of mention $F_1(1, 46) = .962$, p = .438; $F_2 (1, 22) = .783$ p = 322 and no

order/age interaction was found $F_1(1, 46) = .939$, p = .338; $F_2(1, 22) = .894$ p = 432.

However, it seems from figure 6.1, the impact of labelling a character with a

name does not appear numerically quite as strong in the older sample when a proper

name appears first then a role. Despite the lack of an interaction, a tentative and

exploratory analysis was carried out, separately comparing young vs. old in the Name-

Role condition and Role-Name condition. There was a marginally reliable difference in

the Name-Role condition between the younger (Name-Role mean = .937, S.D = .198) and

the older adults (Name-Role mean =.642, S.D =.216) with t (46) = 1.805, p = .078. There

was not a reliable difference in the Role-Name condition between the younger (Role-

Name mean = .976, S.D =.195) and the older adults (Role-Name mean =.923, S.D =.202)

with t (46) = .542, p = .590.

Previously, Sanford, Moar & Garrod (1988) found that it was only the type of

description (a proper name) that influenced the subject of the continuation sentence. The

findings from this study indicate that both age groups were indeed more likely to refer to

a named character rather than a role description. However, there was some marginal

evidence to suggest that the impact of labelling a character with a name was not as strong

in the older sample when the initial sentence contains the proper name and that there is

thus some influence of recency.

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EXPERIMENT 9

In the next experiment, I was concerned with the effect of the name/role distinction on the integration of sentences containing anaphors to the sentences containing the name/role descriptions. Previously, Sanford, Moar and Garrod (1988) found in a self-paced reading task that named characters were more available for anaphoric reference than characters described by a role, regardless of order. I aimed to replicate these findings, and see whether any effects obtained are modified by age.

Method

Design and Materials

This study used a 2x2x2 mixed factor design with Order of Mention (Name-role vs. Role-name), Anaphoric probe (NP1 vs. NP2) and age (young vs. old) being the independent variables. The experimental materials from experiment 7 were modified, and examples are given in table 6.2. There were 32 experimental materials in four different scripts each containing 8 items based on those used by Sanford, Moar and Garrod (1988). The first sentence either included a proper name, followed by second sentence containing a role description (order NAME/ROLE), or the initial sentence contained a role followed by a second sentence containing a proper name (order ROLE/NAME). Within all materials, the name or role was stereotypic of different genders. Of the proper names used, half were stereotypically female and half were stereotypically male.

Table 6.2 – Examples of the type of experimental materials used.

Name-Role order of mention (NR)	Role-Name order of mention (RN)
Mr Branson was dictating a letter. The secretary was taking shorthand. It was getting to be late in the afternoon. He was beginning to feel hungry.	The Manager was dictating a letter. Jane was taking shorthand. It was getting to be late in the afternoon. She was beginning to feel hungry.
Question: Was the secretary on the phone?	Question: Was Jane on the phone?

The descriptions used were designed so that the roles would appear as unambiguous as possible and different with respect to gender, in order to investigate the impact of order of mention and character description on anaphoric resolution.

One of the characters might be expected by default to be male (e.g., Manager), then the other was arranged to be expected by default to be female (e.g., Secretary). This was assessed by pre-testing for gender differences on a scale of 0 (typically male) to 7 (typically female). 5 participants rated the perceived gender differences between the role descriptions (typical male mean = 1.8, typical female mean = 4.8). Roles were chosen that showed a strong bias towards either a male or female being in that occupation.

The third sentence was a neutral statement referring to neither character. The final (target) sentence contained a sentence-initial anaphoric pronoun to either the name or the role character, and was consistent with what might be expected of that character. This was then followed by a comprehension question that either referred to a named

character or a role in order to check that participants were reading the sentences for the sake of comprehension. Half of the questions were designed to give a Yes answer and other half were designed to give a No answer.

Each file contained one of the four possible versions of each item, but overall contained an equal number of all conditions, and so that participants did not see more than one version of any given item. In addition to this there were 64 filler materials from an unrelated experiment. There were thus 4 conditions in all: 2 (antecedent sentence type) plus 2 (anaphor referring to NP1 or NP2).

Participants

32 younger adults (mean age = 21, 20 women, 12 men) with an age range of 18 to 28 years old and 32 healthy older adults (mean age = 71, 20 women, 12 Men) with an age range of 65 to 92 years old from the Glasgow University community took part in the experiment. Older participants were reimbursed any transportation expenses. All were native English speakers of English. The sample of participants did not take part in the previous experiment.

Participants were also required to complete the National Adult Reading Test (Nelson, 1982). This was done in order to gauge basic intelligence level of all the participants. Demographic information such as occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was slightly but significantly higher for older adults (mean predicted I.Q = 116.97, S.D = 8.487) than younger adults (mean predicted I.Q = 112.32, S.D = 6.19), t (62) = 5.129, p

=.001). The mean score of the participants years of education was slightly but significantly higher for younger adults (mean years of education = 17.5, S.D =1.47) than older adults (mean years of education =12.34, S.D =2.32), t (62) = 4.439, p=.001).

Procedure

Experimental procedures were identical to those described in Experiment 2 in chapter 3.

Results

Question Accuracy

There was a high proportion of correct answers to the comprehension questions on the critical materials (see table 6.3) and none of the numerical differences were statistically reliable.

Table 6.3 – Antecedent sentence types and the percentage of correct answers at each age level.

	Percentage correct for Named character	Percentage correct for the role description
Young	91.8%	89.1%
Old	87.9%	90.3%

Reading time

The target sentence reading time data is shown in figure 6.2. ANOVAs were computed for participants (F1) and items (F2).

Figure 6.2 shows the mean target sentence reading times and standard errors for order of mention, and anaphoric probe conditions at each age level.

It is clear from figure 6.2, that while older adults had overall longer reading times than younger adults, the pattern of results is not similar for both age groups. Younger adults appear to show reduced processing times to the named character irrespective of the order of mention. However, while older adults also appear to show reduced reaction times to the target sentence referring to the named character than the role in the Name-Role ordering, it was the opposite pattern of results in the Role-Name condition. They seem to display a primacy effect where they seem to show reduced processing times to the target sentence referring to the first character than the second character.

There was a main effect of age; older adults had significantly longer reading times than younger adults, with $F1 (1, 62) = 10.76$, p=.002; $F2 (1, 30) = 46.990$, p<.0001.

There is a significant effect of anaphoric probe; with $F_1 (1, 62) = 44.84$, $p < .0001$; $F_2 (1, 30) = 89.003$, $p < .0001$. Overall, reading times were shorter for probes to the name, participants were significantly more likely to have reduced processing time to the target sentence referring to the named character than the role in the Name-Role condition. There was also an interaction between order of mention and anaphoric probe; with $F_1 (1, 62) = 9.89$, $p = .003$; $F_2 (1, 30) = 3.91$, $p = .052$. There is also a highly reliable interaction between age and anaphoric probe, with $F_1 (1, 62) = 27.752$, $p = < .0001$; $F_2 (1, 30) = 56.68$, $p < .0001$. Most importantly, there was a highly reliable 3-way interaction between age, order of mention and anaphoric probe, with $F_1 (1, 62) = 21.55$, $p < .0001$; $F_2 (1, 30) = 29.35$, $p < .0001$. This three way interaction is the likely explanation of the other interactions. Older adults show reduced reaction times to the target sentence referring to the named character than the role in the Name-Role; it was the opposite pattern of results in the Role-Name condition. They show reduced processing times to the target sentence referring to the first character than the second character. To clarify these trends, additional analyses were carried out on reading times partitioned by age

Younger adults Reading times

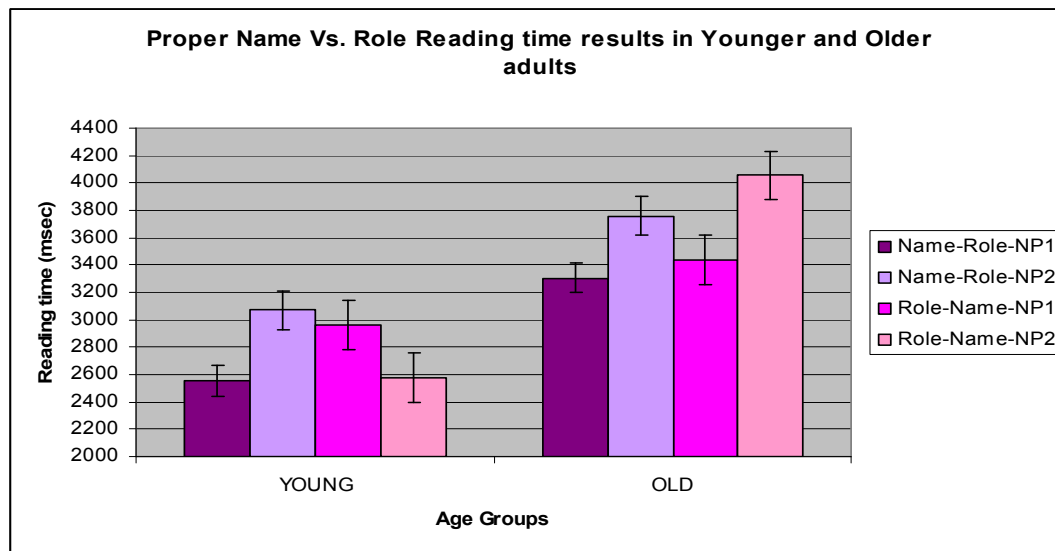ANOVAs were computed for participants (F1) and items (F2).

Figure 6.3 shows the younger adult's mean target sentence reading times and standard errors for order of mention, and anaphoric probe conditions.

There was a significant main effect of anaphoric probe; with F1 (1, 31) = 4.927, p = .034; F2 (1, 31) = 4.819, p = 0.36. Participants were significantly more likely to have reduced processing time to the target sentence referring to the named character than the role in the Name-Role and Role-Name conditions. There no main effect of order of mention; with F1 (1, 31) = .158, p = .694; F2 (1, 31) = .211, p = .649. The analysis showed there was a significant interaction between order of mention and anaphoric probe; with F1 (1, 31) = 30.066, p <.0001; F2 (1, 62) = 47.630, p<.0001. Younger adults showed reduced processing times to the named character irrespective of the order of mention.

<u>Older adults Reading times</u>

ANOVAs were computed for participants (F1) and items (F2). It is clear from figure 6.4, older adults also appear to show reduced reaction times to the target sentence

referring to the named character than the role in the Name-Role; it was the opposite

pattern of results in the Role-Name condition. They seem to display a primacy effect

where they seem to show reduced processing times to the target sentence referring to the

first character than the second character.

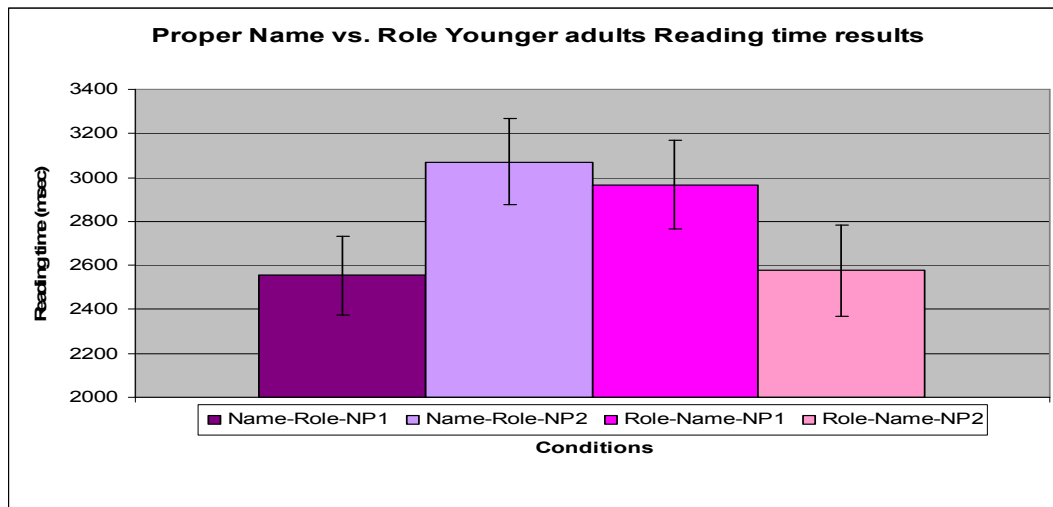**Proper name vs. Role Older adults Reading time results**
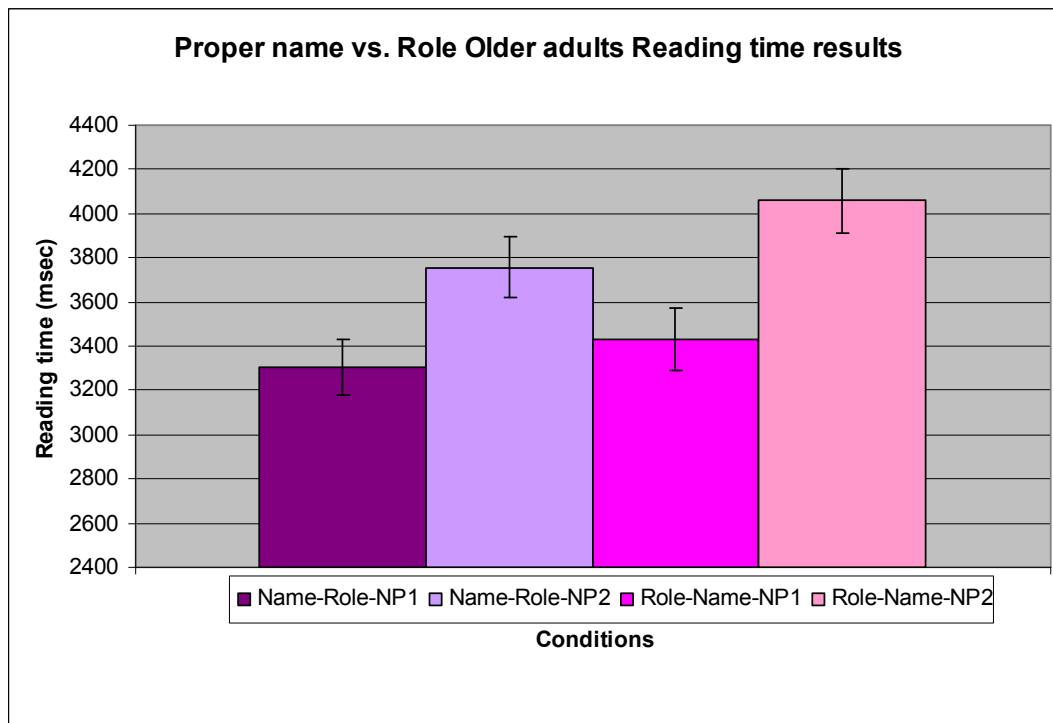
Figure 6.4 shows the older adult's mean target sentence reading times and standard errors

for order of mention, and anaphoric probe conditions.

There was a marginally significant main effect of order of mention; with $F1 (1, 31) = 3.545$, $p = .06$; $F2 (1, 31) = 3.319$, $p = 0.072$. There was a significant main effect of anaphoric probe; with $F1 (1, 31) = 89.238$, $p<.0001$; $F2 (1, 31) = 88.205$, $p<.0001$. However, these effects are modified by a significant interaction between order of mention and anaphoric probe; with $F1 (1, 31) = 4.15$, $p = 0.05$; $F2 (1, 31) = 3.531$, $p = .069$, however this was marginal by items. Older adults show reduced reaction times to the

target sentence referring to the named character than the role in the Name-Role; it was the opposite pattern of results in the Role-Name condition. They show reduced processing times to the target sentence referring to the first character than the second character.

DISCUSSION

Previously, Sanford, Moar & Garrod (1988) found in a self-paced reading task that anaphoric sentences with references to named characters were processed more rapidly than when the anaphors referred to role descriptions. Furthermore, there was no effect of order of mention of named and role-described characters. Although this is true of the young participants, it is not true of the older sample. Older adults instead displayed a first-mention advantage in the Role-Name condition where they were more likely to respond faster to the target sentence referring to the first character than the second character. Since the results for the Name-Role ordering in the older sample is confounded with a first-mention advantage, it is probably wisest to infer that the reading time behaviour of the older group may be entirely governed by first-mention. The fact that the named character seemed to be more available for continuation (Experiment 7) even for the older sample suggests that the older sample are indeed sensitive to this cue, but that during reading, something different is happening, and the cue is not strong enough to overcome a tendency towards first mention driving processing. This is a strong effect, but the origins of the age difference are unclear. I shall return to the issue later. In the next experiment, I used eye tracking and memory probe as for the other cues examined in earlier chapters.

In the next experiment, I examined two things. Whether introducing a character with a proper name is more available even after a delay than a role description. Are the effects due to encoding (tested through eye-movements') and finally, is there an age differential?

EXPERIMENT 10

The key questions here are whether probe performance matches the finding of Experiment 8, including the age differences obtained there. In addition, how does the cue of description type influence the pattern of eye-tracking, and would this offer an explanation of the probe results, and the results of Experiment 8, in terms of encoding? These latter questions are of course augmented by the question of whether there are age-related eye-tracking differences that might provide an explanation for any age-differences observed.

Method

Participants

28 younger adults (mean age =21.5, 17 women, 11 men) with an age range of 18 to 31 years old and 28 healthy older adults (mean age =70.5, 18 women, 10 Men) with an age range of 61 to 86 years old from the Glasgow University community took part in the experiment and were each paid £6. Older participants were also reimbursed any transportation expenses. All were native English speakers with normal or corrected-to-normal vision. The sample of participants did not take part in the previous experiment.

Participants were required to complete the National Adult Reading Test (Nelson, 1982). This was done in order to gauge basic intelligence level of all the participants. Demographic information such as occupation, age and number of years in education was also asked as well as any pertinent medical information.

The mean predicted I.Q score on the National Adult Reading Test (Nelson, 1982) was significantly higher for older adults (mean predicted I.Q =118.43, S.D =3.33) than younger adults (mean predicted I.Q = 113.14, S.D =2.92), t (54) = 6.29, p<.0001). The mean score on the Wechsler Adult Intelligence digit span test (WAIS-III) was slightly but significantly higher for younger adults (mean digit span = 19.36, S.D =.82) than older adults (mean digit span =17.93, S.D =1.90), t (54) = 3.64, p=.001).[6] The mean score of the participants years of education was not significantly higher for younger adults (mean years of education = 16.29, S.D =2.74) than older adults (mean years of education =15.04, S.D =3.56), t (54) = 1.47, p=.147).

Materials and Design

The design of this study was a 2(order of mention - name role/role name) x 2(anaphoric probe - name vs. role) x 2(young vs. older adults) design. Modified versions of the thirty-two experimental materials used in Experiment 9, plus four new items, were used. Examples of experimental items are shown in Table 6.4. The first sentence was a context sentence introducing the scene with no emphasis on either character. The critical sentence either included a name, followed by a role (order Name-Role), or the critical sentence contained a role followed by a name (order Role-Name). Note that the final

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[6]Correlations between digit span and probe recognition accuracy produced no significant trends and are given in appendix three.

sentence in this case does not contain a sentence-initial anaphoric pronoun to either the named character or the role description. Probe names or a role was displayed after participants finished reading a block of passages. Word length could influence the likelihood of recognising a probe; the critical nouns were matched across conditions for length and no significant differences were found. The length of the nouns in the name conditions averaged 6.86 (min. = 4, max. = 11) characters, while the nouns in the role condition averaged 7.11 (min.= 5, max.= 11) characters. Hence, any difference in reading times between conditions will not to be due to discrepancies in length of the nouns.

Table 6.4 – Example of text passages followed by the probe name or role description.

Order of mention	Name-Role	Role-Name
Test Material	It was getting late in the afternoon. Currently Mr Branson was dictating a letter and the secretary was taking shorthand. They were both feeling a little bit hungry.	It was getting late in the afternoon. Currently the executive was dictating a letter and Jane was taking shorthand. They were both feeling a little bit hungry.
Probe	Mr Branson or Secretary	Executive or Jane

One version of each item was assigned to one of two files. The 36 experimental items were assigned to the files so that equal numbers of each condition appeared in each file, with one version of each item appearing in each file, and so that participants did not

see more than one version of any given item. The items were displayed with one hundred and eight filler passages and probes from an unrelated experiment. At least one filler item intervened between each experimental item.

Procedure

The probe recognition task, eye tracking and experimental procedures were identical to those in described in chapter 4 (experiment 4).

RESULTS

Probe Accuracy Results

	Name-Role Name probe	Name-Role Role probe	Role-Name Role probe	Role-Name Name probe
Young	76.22 (1.71)	64.67 (1.52)	64.67 (1.71)	71 (1.77)
Old	76.22 (1.46)	70.67 (2.04)	77.33 (1.77)	71.78 (1.67)

Table 6.5 Mean percentage correct detections for probes, with standard errors.

It is clear from table 6.5, that both young and older adults recognised more named characters in the Name-Role condition; it was the opposite pattern of results in the Role-Name condition for the older adults. ANOVAs were computed by participants (F1) and items (F2) on the accuracy data. There was no main effect of age, with $F_1 (1, 54)=.382$, $P=.530$; $F_2 (1, 34)=2.39$, $p=.112$. There was a marginal main effect of anaphoric probe,

with F1 (1, 54) = 3.315, p=.074; F2 (1, 34) = 2.099, p=.152, There was an interaction between Order of mention x anaphoric probe, with F1 (1, 54)=4.62, p=.036; F2 (1, 34)=4.544, p=.037. Most importantly, there was also a three-way Interaction between Order of mention x anaphoric probe x Age, with F1 (1, 54)=4.62, p=.036; F2 (1, 34)=4.544, p=.037. This three way interaction is the likely explanation of the other interactions. To clarify these trends, additional analyses were carried out on the probe results partitioned by age.

Younger adults' Probe Accuracy Results

ANOVAs were computed for participants (F1) and items (F2). There was a main effect of anaphoric probe, with F1 (1, 27) = 4.109, p=.0.05; F2 (1, 35) = 4.804, p=.035. Young participants were more accurate with names rather than roles regardless of position.

Older adults' Probe Accuracy Results

ANOVAs were computed for participants (F1) and items (F2). There was an interaction between Order of mention x anaphoric probe, with F1 (1, 27)=9.096, p=.006; F2 (1, 35)=10.329, p=.003, Older adults displayed a first mention probe accuracy advantage, consistent with the findings of the anaphoric reference study.

Reaction Time to Probe

	Name-Role Name	Name-Role Role	Role-Name Role	Role-Name Name
Young	1129 (254)	1269 (371)	1231 (397)	1146 (228)
Old	1414 (403)	1741 (511)	1450 (532)	1731 (855)

Table 6.6 Mean target recognition time and standard error.

It is clear from figure 6.6, that the pattern of results is not similar for both age groups. Younger adults appear to show reduced reaction time to probe to the named character irrespective of the order of mention. However, while older adults also appear to show reduced reaction time to probe referring to the named character than the role in the Name-Role; it was the opposite pattern of results in the Role-Name condition. This pattern conforms to that found in the previous experiment.

Analyses of variance showed that there was a main effect of age; older adults had significantly longer reaction to probe times than younger adults, with F_1 (1, 54) =18.082, P<.0001; F_2 (1, 34) =27.197, p<.0001. There was a significant effect of anaphoric probe with F_1 (1, 54) = 13.31, p=.001; F_2 (1, 34) = 8.858, p=.004. There was a 3-way interaction between age, order of mention and anaphoric probe, with F_1 (1, 54) =9.280, p=.004; but this was marginal by items, F_2 (1, 34) =3.548, p=.064. To clarify these trends, additional analyses were carried out on reading times partitioned by age.

Younger adults' reaction time to probe results

ANOVAs were computed for participants (F1) and items (F2). There was a significant main effect of anaphoric probe; with $F1 (1, 54) = 14.349$, $p=.001$; $F2 (1, 34) = 10.719$, $p=.002$.. Participants had significantly reduced reaction times to probe referring to the named character than the role in both the Name-Role and Role-Name conditions.

Older adults' reaction time to probe results

ANOVAs were computed for participants (F1) and items (F2). There was an interaction between Order of mention x anaphoric probe, with $F1 (1, 27) =5.225$, $p=.03$; $F2 (1, 35)=11.807$, $p=.002$. Older adults show reduced reaction time to probes referring to the named character than the role in the Name-Role; but it was the opposite pattern of results in the Role-Name condition. They show reduced reaction time to probes referring to the first character than the second character, confirming the first-mention bias.

Eye-tracking

Regions of analysis The first and last sentences were treated as whole regions (introduction and end regions) and because these regions were so large and only served the purpose of setting the context and finishing the story, the data from these regions will not be reported. The critical second sentence was divided into two regions for the purpose of aggregating reading times and classifying eye- movements, as shown in (6.8). Both regions contained the same number of words in the two versions and approximately the same number of characters.

Order of mention	Name-Role	Role-Name
Test Material	Currently |Mr Branson was[1] |dictating a letter and the| secretary was [2]|taking shorthand.	Currently the| executive was[1]| dictating a letter and| Jane was[2] |taking shorthand.

Table 6.7 Examples of each sentence type divided into the critical regions.

Regions 1 and 2 (critical) always consisted of the named character or role description plus *was* and thus this region was always two words long. First-pass reading time, First-pass regressions out, regression path time, total reading time and regressions in measures were used to analyse tracking patterns. See Chapter 4, Experiment 4 for full details of these measures of analysis. Prior to analysis, fixations were pooled, truncated or removed if necessary (see Chapter 4 for details of this procedure), which accounted for less than 2% of the data.

First pass reading times

	Name-Role Name Region 1	Name-Role Role region 2	Role-Name Role region 1	Role-Name Name region 2
Young	479.03	381.91	352.95	444.44
Old	583.491	406.83	609.86	450.83

Table 6.8 Mean first-pass reading times per region for each condition at each age level

There was a main effect of age; older adults had significantly longer first pass reading than younger adults, with $F_1 (1, 54) = 8.082$, $P = .005$; $F_2 (1, 34) = 8.261$, $p = .005$. There is a significant effect of anaphoric probe; with $F_1 (1, 54) = 13.31$, $p = .001$; $F_2 (1, 34) = 8.858$, $p = .004$, participants were significantly more likely to have longer first pass reading times to the named character rather than the role in the Name-Role condition.

There was an interaction between order of mention and anaphoric probe; with $F_1 (1, 54) = 115.085$, $p < .0001$; $F_2 (1, 34) = 81.685$, $p < .0001$. There was a 3-way interaction between age, order of mention and anaphoric probe, with $F_1 (1, 54) = 6.653$, $p = .013$; $F_2 (1, 34) = 4.819$, $p = .031$. This three way interaction is the likely explanation of the other interactions. Younger adults had longer first pass reading times in the regions containing the named character regardless of position. Older adults on the other hand, spent longer at the first region whether it contained a name or role. To verify these trends, additional analyses were carried out on reading times partitioned by age.

Younger adults' first pass reading times

ANOVAs were computed for participants (F1) and items (F2). There was a significant main effect of anaphoric probe; with $F_1 (1, 54) = 24.834$, $p < .0001$; $F_2 (1, 34) = 14.828$, $p < .0001$, younger participants were significantly more likely to have longer first pass reading times to the region containing the named character than the role in the Name-Role and Role-Name conditions.

Older adults' first pass reading times

There was an interaction between Order of mention x anaphoric probe, with F1 (1, 27) =63.014, p<.0001; F2 (1, 35)=57.598, p<.0001, older adults show longer first pass reading times to probes containing the named character rather than the role in the Name-Role condition; but it was the opposite pattern of results in the Role-Name condition. They showed longer first pass reading times to probes referring to the first character than the second character. This would be consistent with an encoding explanation of the first-mention effect.

Total reading time

	Name-Role Name Region 1	Name-Role Role region 2	Role-Name Role region 1	Role-Name Name region 2
Young	526.18	500.16	536.46	561.38
Old	737.54	692.30	643.51	647.47

Table 6.9 Mean total reading times per region for each condition at each age level.

There was a main effect of age; older adults had significantly longer total reading times than younger adults, with F1 (1, 54) =18.592, P<.0001; F2 (1, 34) =53.599, p<.0001. There is a significant effect of anaphoric probe; F1 (1, 54) = 12.535, p=.001; F2 (1, 34) = 8.064, p=.006, participants were significantly more likely to have longer total reading times to the named character rather than the role in the Name-Role condition. There was however a marginal interaction between order of mention and

name; with F_1 (1, 54) =3.178, p=.08; F_2 (1, 35)=1.325, p=.254, participants longer total

reading times in the regions containing the named character regardless of position.

Regression out

Table 6.10 shows the mean number of regressions out per region for each condition at

each age level.

	Name-Role Name Region 1	Name-Role Role region 2	Role-Name Role region 1	Role-Name Name region 2
Young	7.97	3.18	3.23	10.89
Old	16.78	5.93	3.89	17.72

There was a main effect of age, with F_1 (1, 54) =5.903, p=.018; F_2 (1, 34)

=8.393, p=.005. Older adults made more regressions compared to younger adults. There

was a main effect of anaphoric probe, with F_1 (1, 54) = 6.762, p=.012; F_2 (1, 34) =

4.136, p=.046, there was a higher probability that a regression would be triggered out of

the region containing the named character regardless of order of mention.

There was also an interaction between order of mention and anaphoric probe, with

F_1 (1, 54) =47.453, p<.0001; F_2 (1, 35)=87.575, p<.0001, there was a higher probability

that a regression would be triggered out of the region containing the named character

regardless of the order of mention. This result indicates that participants were more likely to reread the portion of a sentence containing the named character.

Regression path

	Name-Role Name Region 1	Name-Role Role region 2	Role-Name Role region 1	Role-Name Name region 2
Young	515.35	491.84	475.04	526.86
Old	670.03	551.95	605.42	646.77

Table 6.11 shows the mean regression path times per region for each condition at each age level.

There was a main effect of age, with F_1 (1, 54) =3.959, P=.052; F_2 (1, 34) =16.281, p<.0001, older adults had longer regression path reading times compared to younger adults. There was a main effect of anaphoric probe, with F_1 (1, 54) = 6.761, p=.012; F_2 (1, 34) = 6.073, p=.016. Participants were significantly more likely to have longer regression path times to the named character regardless of the order of mention.

Regression in

Table 6.12 shows the mean number of regressions in per region for each condition at each age level.

	Name-Role Name Region 1	Name-Role Role region 2	Role-Name Role region 1	Role-Name Name region 2
Young	19.50	7.19	5.39	24.52
Old	38.87	17.64	15.28	36.55

There was a main effect of age, with F1 (1, 54) =18.329, P<.0001; F2 (1, 34) =48.134, p<.0001. Older adults made more regressions compared to younger adults. There was an interaction between order of mention and anaphoric probe, with F1 (1, 27) =98.014, p<.0001; F2 (1, 35)=144.990, p<.0001, there was a higher probability that a regression would be triggered into the region containing the named character regardless of the order of mention. This result indicates both young and older adults were more likely to reread the portion of a sentence containing the named character.

Is probe recognition accuracy due to a lack of encoding?

To investigate the possibility the probe recognition results is due to a lack of encoding, I correlated the performance on the probe accuracy scores with the critical regions' total time measure.

	Name-Role-Name Probe Total Time	Name-Role-Role Probe Total Time	Role-Name-Role Probe Total Time	Role-Name-Name Probe Total Time
Young Probe Recognition	-.136	.041	.328	-.134
Old Probe Recognition	.140	.341	.200	.035

*Correlation is significant at the 0.05 level

Table 6.13 shows the correlations between probe recognition accuracy and critical total time region.

As table 6.13 shows, older adults demonstrated an overall pattern of positive correlations between probe recognition and total time, while younger adults showed a mixed pattern of positive and negative correlations. None of these correlations were statistically reliable. These findings suggest the possibility that the failure to recognise a probe word is not due to a lack of encoding.

DISCUSSION

The current experiment aimed at testing whether the differences between young and older adults use of the named cue is explained in their patterns of eye movements. Probe words were much more readily recognised when they were referred to a named character but this pattern was found only in the younger participants. Older adults displayed a first mention probe accuracy advantage in the probe recognition which is consistent with the findings from the previous experiment. The eye-tracking results showed some evidence of longer reading times to probes referring to the first character than the second character in older adults but not younger adults. This would be consistent with an encoding explanation of the first-mention effect.

GENERAL DISCUSSION

Existing evidence suggested that named characters are given a privileged role in subsequent processing over role descriptions (e.g., Sanford, Moar & Garrod, 1988). The findings show that older and younger subjects have different processing patterns based on this type of cue, unlike the findings for information structuring cues. The results from experiment 8 showed that both age groups were more likely to refer to a named character rather than a role description, indicating that both were sensitive to the proper/name distinction, as measured by the sentence continuation. The present studies suggest both young and older adults integrate with ease a named character in the Name-Role condition, but in the Role-Name condition, older adults displayed a first-mentioned advantage.

It is important to note there was no evidence of any deterioration in the older adults' ability to respond to naming as a cue. Incidentally, these findings might seem to run against some studies that have shown older adults have greater retrieval difficulty for names rather than occupations (e.g., Cohen & Faulkner, 1984, 1986; Barresi et al., 1998; James, 2004; 2006; Fogler & James, 2008).

However, in the self-paced reading task (experiment 9) older adults instead displayed a first-mentioned advantage in the Role-Name condition where they were more likely to respond faster to the target sentence referring to the first character than the second character. When the order of mention was Name-Role, naming facilitated the integration of an anaphoric sentence, which can be clearly seen by the reduced reading times. In the Name-Role condition, a named character facilitated the integration of an

anaphoric sentence which can be clearly seen by the reduced reading times but only for the younger age group. The older age group showed reduced processing time when referring the target sentence referred to the first character than the second character in the Role-Name condition.

Experiment 10, using a delayed probe recognition task, replicated and extended the previous findings by Cooreman and Sanford (1996) for younger adults only. In the present study, late probes were much more readily recognised, and participants' showed reduced reaction times, when the probe was a named character than when the probe word was a role description, irrespective of order of mention. Older adults displayed poorer recognition rates and increased reaction to probe times when the probe were contained in the second position compared to younger adults. This pattern of results in experiments 9 and 10 are consistent with the findings of Gernsbacher and her colleagues, where participants mentioned first are more available after a delay (e.g., Gernsbacher & Hargreaves, 1988; Gernsbacher, Hargreaves & Beeman, 1989).

The issue as to how the proper name/role contrast affects eye movement patterns is less clear. As far as I am aware there is no existing work on this issue. The first path and total time reading measures showed that both age groups spent longer looking at the region containing the named character in the Name-Role condition, but older adults displayed longer looking at the initial region whether it contained a name or a role. The regression path reading measure showed that both age groups spent longer looking at the region containing the named character.   There were more regressions out of the region containing the named character regardless of order of mention. The same pattern also occurred for regressions into the initial region. This ruled out the possibility that the

failure to detect named characters probes is due to a lack of encoding. These findings are consistent with one previous investigation on a related issue by Birch and Rayner (1997) that found that reading times were longer for focused than for non-focused words. Unlike the findings of another similar eye tracking study by Morris and Folk (1998) which found readers spent longer on the non-focused words rather than the focused words.

It is unclear how the proper name/role distinction influences the deployment of processing in the elderly as it does in the young. Older adults showed a first character advantage in the self-paced reading task and the delayed probe recognition task. This would be consistent with an encoding explanation of the first-mention effect.

CHAPTER 7: SUMMARY AND GENERAL CONCLUSIONS

SUMMARY

The studies presented in this thesis investigated whether there are any differences in the use of information structuring cues as a result of normal ageing. As far as I am aware, no existing research has been conducted to investigate whether the aging process results in an increase in the reliance on focus cues. There are many techniques that can be used to draw a reader's attention to important information such as focus (e.g., Sanford, 2002; Sturt et al., 2004), subordination (Baker & Wagner, 1987; Cooreman & Sanford, 1996) and proper name/role contrast (Sanford, Moar & Garrod, 1988). Sturt et al. proposed that devices signalling prominence cause readers to attempt to build representations at the finest, most specified grain that is useful to the current processing demands (Sturt et al, 2004). This is just one of several ideas of how prominence modulates subsequent processing.

It is known older adults have limited processing resources under certain conditions (e.g., Hamm & Hasher, 1992) thus marked focused structures could ease processing demands. Focus information is used over a lifetime, therefore it is conceivable older adults have much greater exposure to information structuring cues compared to younger adults. Thus it is possible that the selectivity resulting from focus might be maintained in normal adult ageing, or might even be enhanced, resulting in a means of offsetting other comprehension difficulties. However, previous findings have shown that inhibitory processes weaken with increasing age (e.g., Hasher & Zacks, 1988). Since selective attention is compromised in this way, a decline in the effectiveness of focus cues for selective processing with age might be expected instead. At the outset of the thesis, the question was thus an open one.

The experiments in this thesis manipulated several focus devices, enabling the investigation of a range of established cues that control selective processing in younger adults. For instance, when a word is in focus, it tends to be more extensively processed, and hence represented in more detail in both written and spoken modes in the young (e.g., Sturt et al., 2004; Sanford et al., 2006). Focus is a device that facilitates the structuring of information, indicating which parts of a text are important, and which are not (e.g., Sanford, 2002). Previous studies have shown that focus has a strong impact on readers' discourse representations by strengthening the memory trace for focused concepts (e.g., Birch & Garnsey, 1995; Birch et al., 2000, Foraker & McElree, 2007).

Related attention capturing devices (subordination and name/role distinction) have also shown that aspects of the status of characters lead to focus-like effects in the discourse. Existing evidence suggests that information contained in the main clause of complex sentences are given more prominence in subsequent processing than information contained in the subordinate clauses (e.g., Cooreman & Sanford, 1996). There is also evidence to show that named characters (such as *Mr. Baker*) are more likely to be referred to in a sentence continuation task and are therefore more prominent than characters described by a role description (such as *the baker*) (Sanford, Moar & Garrod, 1988).

The main method used to answer whether older adults were sensitive to focus cues was a simple continuation task. In order to answer whether the effect of focus has a greater impact on the older age group, I compared performance levels on the different attention capturing devices (focus, subordination and name/role distinction) using self-paced reading, eye-tracking and probe recognition. I combined eye-tracking with the

probe recognition task to see whether a difference in recognition performance is due to encoding. The one change detection study provided further evidence that focus influences memory representation.

Experiment 1 showed that both young and older adults are equally sensitive to information structuring cues using a sentence continuation task. The results from experiments 2, 3 and 4 showed that focus increases the processing efficiency of anaphoric references, facilitates probe recognition and increases change detection when elements are within the scope of focus (see table 7.1 for a summary of the main findings). The principal findings from the eye-tracking measures showed that both age groups spent longer on the critical region in the focused condition, followed by the baseline, and finally by the anti-focused condition.

These findings are consistent with one previous investigation (Birch & Rayner, 1997) that found focused concepts lead to longer reading times, and are contrary to the findings of Morris and Folk (1998). The effect of focus cues on the elderly show no differences from those in the young in eye-tracking, so it is unlikely that more cautious and structured eye-based encoding by the elderly explains the equal or exaggerated performance effects that were shown in earlier experiments. The larger focus effects are partly due to much poorer performance when elements are outside the scope of focus. In some cases, the effect of focus is much more exaggerated in the older sample.

Information structuring findings

Table 7.1 a brief summary of the main findings across the different methodologies.

Chapter 3 Experiment 1	Sentence continuation task	Exaggerated Age Effect
cleft	Participants referred to NP1 relative to baseline	
pseudo-cleft	Participants referred to NP2 relative to baseline	
Chapter 3 Experiment 2	**Self-paced reading task**	
cleft–focused NP1 vs. match NP	Reduction in processing time (enhancement)	
cleft-unfocused NP2 vs. match NP	Increased processing time (suppression)	Yes‡
Pseudo-cleft-focused NP2 vs. match NP	Reduction in processing time (enhancement)	Yes†
Pseudo-cleft-unfocused NP1 vs. match NP	Increased processing time (suppression)	Yes†
Chapter 3 Experiment 3	**Change-detection task – detection rates**	
Focus (pseudo-cleft)	Sharp decline in detection rates when the change is contained in the baseline condition (enhancement)	Yes‡
Anti-focus (cleft)	Reduction in detection rates when the change is contained in the anti-focused condition (suppression)	
Chapter 4 Experiment 4	**Delayed probe recognition task - probe accuracy & reaction time to probe and eye-tracking results**	
Focus (probe)	Shaper decline in recognition rates when the probe words were contained in the baseline condition (enhancement)	Yes‡
Anti-focus (probe)	Reduction in probe recognition when the probe words were contained in the anti-focused condition (suppression)	
Focus (reaction time to probe)	Reduction in reaction time to probe relative to baseline (enhancement)	Yes‡
Anti-focus (reaction time to probe)	Increased reaction time to probe relative to baseline (suppression)	
Eye-tracking	Participants had longer reading times in the focus condition, followed by the baseline condition and lastly the anti-focused condition.	

‡ Significant interaction by subjects and materials

†Significant interaction by subjects but marginal by items

Foraker and McElree (2007) claim that focus enhancement is the result of a more

distinctive memory representation. The current findings are consistent with this claim

and suggest that the enhancement and suppression effects result from the distinctiveness of the elements in memory. These findings also support the general stand taken by Gernsbacher and Jescheniak (1995) that suppression as well as enhancement effects may modulate ease of reference. Gernsbacher and Jeschniak have demonstrated enhancement and suppression effects in related situations, but they did not directly test whether focus leads to enhanced processing, or suppression in the case of words being out of focus in a sentence that has focus marking.

The uniformity of results from chapters 3 and 4 show that when words are in focus, not only does this enhance their subsequent processing, but protects them from becoming suppressed in the wake of subsequent information, suggesting mechanisms of enhancement and suppression. Thus extending the results found by Sturt et al., showing memory representations are relatively facilitated by focus, but reduced (suppressed) by anti-focus. This in turn is consistent with the view presented in Sturt et al. (2004) that focus serves to enhance the semantic specificity of representation of elements within its scope.

Subordination

Experiment 5 showed that both young and older adults were more likely to refer to the main clause of a sentence whether it was mentioned first or second. The results from experiments 6 and 7 showed that clause status increases the processing efficiency of anaphoric references and facilitates probe recognition when information is contained in the main clause of a sentence (see table 7.2 for a summary of the main findings). The larger clause status effects are partly due to much poorer performance when information

is contained in the subordinate clause of the sentence. In some cases, the effect of clause status is much more exaggerated in the older sample.

The eye-tracking results showed that the failure to detect subordinate clause memory probes is not due to a lack of encoding, as participants had overall longer reading times in the subordinate clause condition compared to the main clause condition. Unlike the previous eye-tracking results from chapter 4, these findings are more consistent with the related study by Morris and Folk (1998) which found increased reading times when elements were unfocused but are not consistent with Birch and Rayner's (1997) findings.

Table 7.2 a brief summary of the main findings across the different methodologies.

Chapter 5 Experiment 5	Sentence continuation task	
Main-Sub	Participants referred to the main clause	
Sub-Main	Participants referred to the main clause	
Chapter 5 Experiment 6	Self-paced reading task	
Main vs. subordinate	Reduction in processing time when the target sentence referred to the main clause but increased processing times when the target sentence referred to the subordinate clause	Yes†
Chapter 5 Experiment 7	Delayed probe recognition task - probe accuracy & reaction time to probe and eye-tracking results	
Main vs. sub (probe)	More probe words contained in the main clause were recognised with a shaper decline in recognition rates when the probe words were contained in the subordinate clause	Yes†
Main vs. sub (reaction time to probe)	Reduction in reaction time to probe when the probe was contained in the main clause. However there is a sharp increase in reaction time to probe when it is in the subordinate clause condition	Yes†
Eye-tracking	Participants had longer reading times in the subordinate clause condition compared to the main clause condition.	

‡ Significant interaction by subjects and materials

†Significant interaction by subjects but marginal by items

The overwhelming uniformity of the findings from chapter 5 clearly demonstrates the order in which the two clauses appear did not have an impact on subsequent processing. This pattern of results refutes Gernsbacher's claim that the first-mentioned character is more extensively processed (e.g., Gernsbacher, 1989). The pattern of results I obtained replicate and extended the previous findings by Cooreman and Sanford (1996). Information contained in the main clause eases anaphoric integration and strengthens memory representation compared to information contained in a less prominent subordinate position.

Proper name/role contrast

It is unclear how the proper name/role distinction influences the deployment of processing in the elderly as it does in the young. The overwhelming uniformity of the findings in the younger adults demonstrated the order of in which two clauses appear did not have an impact on subsequent processing. Other aspects appear to have overcome the named character advantage in the older adults such as first-mention or recency (see table 7.3 for a summary of the main findings). Experiment 8 showed that both young and older adults were sensitive to the naming cue with a slight tendency to produce sentences referring to the second-mentioned character in the older adults.

Chapter 6 Experiment 8	Sentence continuation task
Name-role	Participants referred to the named character although there was a marginal second-mentioned advantage in the older age group
Role-Name	Participants referred to the named character
Chapter 6 Experiment 9	Self-paced reading task
Name vs. role	Reduction in processing time when the target sentence referred to the named character in the younger age group but older adults displayed a first-mentioned advantage.
Chapter 6 Experiment 10	Delayed probe recognition task - probe accuracy & reaction time to probe and eye-tracking results
Name vs. role (probe)	Named characters were recognised more in the younger adults but older adults recognised more individuals when they had been mentioned first.
Name vs. role (reaction time to probe)	Reduction in reaction time to probe when it was the named character in the younger adults but older adults displayed a first-mentioned advantage.
Eye-tracking	Participants had longer reading times in the proper name condition but older adults displayed a first-mentioned advantage.

Table 7.3 a brief summary of the main findings across the different methodologies.

The cue does not appear strong enough to overcome a tendency towards first mention driven processing in anaphoric integration and memory representation in the older adults. The results from experiments 9 and 10 are more consistent with Gernsbacher's encoding explanation of the first-mention effect, but only for the older group.

FUTURE WORK

There are obviously other experimental techniques and factors which need to be investigated regarding what influences the depth of language processing in healthy older adults that this thesis did not examine.

Gender Differences

One issue which this thesis did not examine is whether there are any differences in the use of focus cues between older males and females. As far as I am aware, no existing research has been conducted to investigate whether there are any gender differences in the use of information structuring cues in the ageing process. It was not possible to examine gender differences in the course of this thesis due to unequal numbers of males and females who participated in the research. There is evidence to suggest that older adults have a vocabulary advantage over the young the age differential is smaller, however, it is unclear whether this advantage is divided equally between the sexes (e.g., Johnson, 2003). Both older men and women have a greater linguistic experience compared with the younger sample so this would suggest that they are equally responsive to information structuring cues. Ultimately, only further experimentation specifically aimed at comparing gender differences or a longitudinal study will reveal how the age effects reported here differentiate between older men and women.

Proper Name

A further technique to tease about the issue of how the proper name/role contrast is modulated by adult ageing could be the 'visual world' paradigm which measures language-mediated eye- movements around a visual scene. It has been shown that eye-movements can be directed by auditory input towards appropriate objects in a visual display, reflecting the cognitive processes that underlie language comprehension (Cooper, 1974; Tanenhaus, Spivey-Knowlton, Eberhard & Sedivy, 1995). There is evidence to suggest that the eyes can move towards a corresponding critical object *before*

a word referring to that object is available. Altmann and Kamide (1999), for example, demonstrated that when an auditory sentence such as, *'the boy will eat the cake'* is paired with a visual display depicting a boy and a cake (among other objects), participants launch anticipatory eye-movements towards the cake during the verb *'eat'*. This method could determine whether the elderly are more influenced by the first-mentioned character. Using the materials from experiment 9, participants could listen to the first two sentences introducing the named character or role description, before listening to a target sentence referring to either character paired with a visual display depicting a man and a ballerina (among other objects). This could provide a conclusive answer as to whether older adults are able to use the name/role distinction to influence anticipation towards visually presented referents or if it is simply the first-mentioned advantage.

Changes in processing depth with focus

Several studies have highlighted how focus can increase the extent, or impact of semantic analysis (e.g., Erickson & Mattson, 1981; Bredart & Modolo, 1988; Sturt et al, 2004; Baker & Wagner, 1987). It has been shown to modulate semantic anomaly detection, whereby anomalies that are placed within the focus of a sentence are detected more frequently, than the same anomalies placed in an unfocussed position but how this is mediated by adult ageing is not yet know. This technique falls outside the scope of this thesis, however it is potentially a fruitful way to provide converging evidence on the use of information structuring cues (focus & subordination) in the older age group.

There is existing evidence to suggest that older adults' ability to detect semantic anomalies (such as tranquilizing stimulants) is no different from that of their younger

counterparts, however these findings were based on a limited set of experimental items (e.g., Daneman et al. 2006). The issue as to whether placing an anomalous term in focus using a larger set of materials will increase anomaly detection in older adults has not been explored. There is also a need to replicate the findings of Baker and Wagner (1987) that participants were less likely to notice false information when it was contained in the subordinate clause. However, this time using a larger set of materials which do not rely on encyclopaedic knowledge or retrieval of specific facts.

Sentential complexity

The general aim behind this suggestion is to test whether focus can be used to offset the well-known disadvantaging effects of sentence complexity in the elderly fell outside the scope of this thesis. When a sentence is difficult to process due to complex syntax, resources that might have been used on semantic processing could be compromised to a greater extent in the older age group (e.g., Kemper & Liu, 2006). It is known that sentences containing object-extracted relative clauses (e.g., 7.2) are more difficult to read than those containing subject-extracted clauses (2) (Gibson, 1998; Gordon, Hendrick & Johnson, 2001; Grodner & Gibson, 2005):

7.1 The reporter who sent the photographer hoped for a story.

7.2 The reporter who the photographer sent hoped for a story.

It has been well-documented that object-extracted sentences lead to an increase in processing difficulty which in turn results in slower reading times (e.g., Gordon *et al*.,

2001; Grodner & Gibson, 2005). It reduces the extent or quality of processing as revealed by a drop in change detections (Sanford *et al*, 2005). However, not all sentences containing object-extracted relative clauses are difficult to process if they contain a first- or second-person pronoun (indexical pronouns) rather than a full noun-phrase (e.g., Bever, 1970, Bever, 1974 and Kac, 1981) and examples from Warren and Gibson (2002) shown below illustrate the differences in processing difficulty:

7.3 The professor who the student had recently met at a party was famous, but no-one could work out why.

7.4 The professor who I had recently met at a party was famous, but no-one could work out why.

Example (7.3) demonstrates it is much harder to read than (7.4), as (7.3) contains a full definite NP (the student) while (7.4) contains a first-person pronoun (I). A recent change-detection study confirms that it is harder to notice changes to the embedded verb (met) in 7.3 than in 7.4 *(*Sanford *et al,* 2005*)*. A future avenue of research could explore whether focus can be used to offset the well-known disadvantaging effects of sentence complexity (referential load) to detect changes while measuring participants' eye-movements. How exactly to measure this issue is not clear and would require careful thought and controlled materials.

Clinical Applications

The present findings have implications for the way information should be written in health-related or instruction leaflets so the older reader can easily comprehend the important information the writer/speaker is trying to convey. This could also have clinical implications, as a way to effectively facilitate the comprehension of patient groups with working memory impairments (e.g., Alzheimer's or Dementia).

The general aim is to test whether there is any difference in the use of information structuring with patients suffering from early stages of Alzheimer's fell outside the scope of this thesis. There is evidence to suggest while Alzheimer's patients make use of pronouns in production without difficulty, they display serious pronoun-comprehension impairments (Almor, Kempler, MacDonald, Andersen & Tyler, 1999). When Alzheimer's patients were presented with:

7.5   The housewife watched the clumsy plumber working under the sink. The housewife showed the plumber where the leak was. The housewife could not believe that the plumber was so CLUMSY.

7.6   The housewife watched the clumsy plumber working under the sink. She showed him where the leak was. She could not believe that he was so CLUMSY.

The Alzheimer's patients were faster to name the adjective 'clumsy' when repetitive noun phrases in 7.5 rather than through the use of pronouns in 7.6. In contrast, age-matched controls showed the opposite pattern of results. They were faster to name the adjective in 7.6. This would suggest that Alzheimer's leads to a decline in the use of

pronouns and would indicate this could lead to an inability to benefit from information

structuring cues. The present findings have provided a basis to test the ability to use

information structuring cues in a healthy sample in order to compare whether there are

differences in performance in a clinical sample. As far as I am aware, how clinical

populations use information structuring cues is not fully understood and future research

into this issue is the next logical step.

CONCLUSIONS

The present studies suggest that the use of information structuring cues (excluding

naming) is well-preserved in older adults. The larger effects are partly due to much

poorer performance when elements are contained in less prominent positions. It is clear

that information structuring influences the deployment of processing in the elderly just as

much as it does in the young. In some cases, the effect of focus is much more

exaggerated in the older sample. It affects patterns of eye-movements in reading, it

affects anaphoric integration, and it affects memory representation. The influence of the

proper name/role distinction is less clear and does require further investigation.

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APPENDIX 1

<u>Experiment 1 – Focus (cleft, pseudo-cleft and baseline) sentence continuation</u>
1.
What John lost was his hat.
It was John who lost his hat.
John lost his hat.

2.
What Susan lost was her voice.
It was Susan who lost her voice.
Susan lost her voice.

3.
What David wanted was a loaf of bread.
 It was David who wanted a loaf of bread.
David wanted a loaf of bread.

4.
What Jane lost was her mobile phone.
It was Jane who lost her mobile phone.
Jane lost her mobile phone.

5.
What Harry enjoyed eating was the cake.
It was Harry who enjoyed eating the cake.
Harry enjoyed eating cake.

6.
What Paula really wanted was a new fountain pen.
It was Paula who really wanted a new fountain pen.
Paula wanted a fountain pen.

7.
What Jessica loved was her new car.
It was Jessica who loved her new car.
Jessica loved her new car.

8.
What Anthony liked was his new hiking boots.
It was Anthony who liked his new hiking boots.
Anthony liked his new hiking boots.

9.
What Simon really hated was his passport photo.
It was Simon who really hated his passport photo.

Simon hated his passport photo.

10.
What Laura really liked was her new dress.
It was Laura who really liked her new dress.
Laura liked her new dress.

11.
What Joanne really wanted was a new computer.
It was Joanne who really wanted a new computer.
Joanne wanted a new computer.

12.
What Joe really wanted was a new mobile phone.
It was Joe who really wanted a new mobile phone.
Joe wanted a new mobile phone.

13.
What Paul really needed was new trousers.
It was Paul who needed new trousers.
Paul needed new trousers.

14.
What Sharon threw across the room was a wine glass.
It was Sharon who threw the wine glass across the room.
Sharon threw the wine glass across the room.

15.
What Henry really needed was a new suit.
It was Henry who really needed a new suit.
Henry needed a new suit.

16.
What Harriet really wanted was a new handbag.
It was Harriet who really wanted a new handbag.
Harriet wanted a new handbag.

17.
What Katie stole was a diamond ring.
It was Katie who stole was a diamond ring.
Katie stole a diamond ring.

18.
What Tom dropped was an expensive Ming vase.
It was Tom who dropped an expensive Ming vase.
Tom dropped an expensive Ming vase.

19.
What Lauren really needed was a new watch.
It was Lauren who really needed a new watch.
Lauren needed a new watch.

20.
What Jack wanted was a new radio.
It was Jack who wanted a new radio.
Jack wanted a new radio.

21.
What Dawn really wanted was a new bracelet.
It was Dawn who really wanted a new bracelet.
Dawn wanted a new bracelet.

22.
What Burt lost was his watch.
It was Burt who lost his watch.
Burt lost his watch.

23.
What Courtney really wanted was a new teddy bear.
It was Courtney who really wanted a new teddy bear.
Courtney wanted a new teddy bear.

24.
What Darren needed was new football boots.
It was Darren who needed new football boots.
Darren needed was new football boots.

25.
What Brenda wanted was new pajamas.
It was Brenda who wanted new pajamas.
Brenda wanted new pajamas.

26.
What Jeff played with was a toy train.
It was Jeff who played with a toy train.
Jeff played with a toy train.

27.
What Blythe really needed was a new schoolbag.
It was Blythe who really needed a new schoolbag.
Blythe needed a new schoolbag.

28.

What Edward played with was a toy car.
It was Edward who played with a toy car.
Edward played with a toy car.

29.
What Mary broke was the valuable Royal Dalton plate.
It was Mary who broke the valuable Royal Dalton plate.
Mary broke the Royal Dalton plate.

30.
What Martin stole was the leather wallet.
It was Martin who stole the leather wallet.
Martin stole the leather wallet.

31.
What Judith wanted was a large box of chocolates.
It was Judith who wanted a large box of chocolates.
Judith wanted a large box of chocolates.

32.
What Dennis lost was his keys.
It was Dennis who lost his keys.
Dennis lost his keys.

33.
What Tracy needed was a new pencil case.
It was Tracy who needed a new pencil case.
Tracy needed a new pencil case.

34.
What Patrick stole was a valuable painting.
It was Patrick who stole a valuable painting.
Patrick stole a valuable painting.

35.
What Naomi wanted was a pint of milk.
It was Naomi who wanted a pint of milk.
Naomi wanted a pint of milk.

36.
What Jake wanted was a new car.
It was Jake who wanted a new car.
Jake wanted a new car.

Experiment 2 – focus (cleft, pseudo-cleft and baseline) self-paced reading
1.

What John lost was his daughter.
It was John who lost his daughter.
John lost his daughter.
Target Sentence: He/she had wandered off in the park.

2.
What Susan lost was her brother.
It was Susan who lost her brother.
Susan lost her brother.
Target Sentence: She/he was supposed to be babysitting.

3.
What David missed was his girlfriend.
It was David who missed his girlfriend.
David missed his girlfriend.
Target Sentence: She/he didn't like to be alone.

4.
What Jane lost was her father.
It was Jane who lost her father.
Jane lost her father.
Target Sentence: She/he wished they had spent more time together.

5.
What Harry enjoyed was watching his daughter.
It was Harry who enjoyed watching his daughter.
Harry enjoyed watching his daughter.
Target Sentence: She/he had a big smile on their face.

6.
What Paula ignored was her boyfriend.
It was Paula who ignored her boyfriend.
Paula ignored her boyfriend.
Target Sentence: She/he was being very annoying.

7.
What Jessica loved was her husband.
It was Jessica who loved her husband.
Jessica loved her husband.
Target Sentence: She/he is enjoying married life.

8.
What Anthony loved was his wife.
It was Anthony who loved his wife.
Anthony loved his wife.
Target Sentence: She/he tried to spend as much time together.

9.
What Simon missed was his sister.
It was Simon who missed his sister.
Simon missed his sister.
Target Sentence: She/he had a huge falling out some years ago.

10.
What Laura really liked was her son.
It was Laura who really liked was her son.
Laura liked her son.
Target Sentence: She/he was always smiling.

11.
What Joanne lost her brother.
It was Joanne who lost her brother.
Joanne lost her brother.
Target Sentence: She/he had wandered off in the supermarket.

12.
What Joe lost his little sister.
It was Joe who lost his little sister.
Joe lost his little sister.
Target Sentence: She/he was there a minute ago.

13.
What Paul needed was his mother.
It was Paul who needed his mother.
Paul needed his mother.
Target Sentence: She/he missed their long chats.

14.
What Sharon missed was her husband.
It was Sharon who missed her husband.
Sharon missed her husband.
Target Sentence: She/he hadn't spent a night apart in 10 years.

15.
What Henry needed was to speak to his wife.
It was Henry who needed to speak to his wife.
Henry needed to speak to his wife.
Target Sentence: She/he weren't getting on very well lately.

16.
What Harriet wanted was to visit her son.
It was Harriet who wanted to visit her son.

Harriet wanted to visit her son.
Target Sentence: She/he hadn't seen each other in awhile.

17.
What Katie ignored was her brother.
It was Katie who ignored her brother.
Katie ignored her brother.
Target Sentence: She/he wasn't really a morning person.

18.
What Tom lost was his mother.
It was Tom who lost his mother.
Tom lost his mother.
Target Sentence: She/he was very distressed about it.

19.
What Lauren needed was her husband.
It was Lauren who needed her husband.
Lauren needed her husband.
Target Sentence: She/he was away on business.

20.
What Jack wanted was to visit his sister.
It was Jack who wanted to visit his sister.
Jack wanted to visit his sister.
Target Sentence: She/he was living abroad these days.

21.
What Dawn really missed was her son.
It was Dawn who really missed her son.
Dawn missed her son.
Target Sentence: He/she hadn't spoken to each other in years.

22.
What Burt lost was his wife.
It was Burt who lost his wife.
Burt lost his wife.
Target Sentence: She/he had been ill for a long time.

23.
What Courtney really missed was her baby brother.
It was Courtney who really missed her baby brother.
Courtney missed her baby brother.
Target Sentence: She/he is very close.

24.
What Darren needed to speak to his daughter.
It was Darren who needed to speak to his daughter.
Darren needed to speak to his daughter.
Target Sentence: She/he needed to go shopping later.

25.
What Brenda wanted was her husband.
It was Brenda who wanted her husband.
Brenda wanted her husband.
Target Sentence: She/he was sick of living apart.

26.
What Jeff played with his sister.
It was Jeff who played with his sister.
Jeff played with his sister.
Target Sentence: She/he liked spending time together.

27.
What Blythe needed was to speak to her father.
It was Blythe who needed to speak to her father.
Blythe needed to speak to her father.
Target Sentence: She/he was running late.

28.
What Edward played with was his daughter.
It was Edward who played with his daughter.
Edward played his daughter.
Target Sentence: She/he could spend hours together.

29.
What Mary decided was to split up with her boyfriend.
It was Mary who decided to split up with her boyfriend.
Mary decided to split up with her boyfriend.
Target Sentence: She/he took time to get over the relationship.

30.
What Martin loved was his grandmother.
It was Martin who loved his grandmother.
Martin loved his grandmother.
Target Sentence: She/he liked spending time together.

31.
What John wanted was to speak to his girlfriend.
It was John wanted was to speak to his girlfriend.
John wanted to speak to his girlfriend.

Target Sentence: She/he hadn't come home last night.

32.
What Dennis lost was his girlfriend.
It was Dennis who lost his girlfriend.
Dennis lost his girlfriend.
Target Sentence: She/he was by the bar.

33.
What Tracy missed was her son.
It was Tracy who missed her son.
Tracy missed her son.
Target Sentence: She/he was away on business a lot.

34.
What Patrick avoided was his sister.
It was Patrick who avoided his sister.
Patrick avoided his sister.
Target Sentence: She/he could be very childish at times.

35.
What Naomi wanted was to live with her boyfriend.
It was Naomi wanted to live with her boyfriend.
Naomi wanted to live with her boyfriend.
Target Sentence: She/he thought it was a very big step in their relationship.

36.
What Jake lost his wife.
It was Jake who lost his wife.
Jake lost his wife.
Target Sentence: She/he was sick of arguing all the time.

Experiment 3 – Focus (focus, anti-focus and baseline) audio change-detection
1.
Most of the students had been concentrating on their revision. What Bill really wanted to pass was German, according to the teaching. The class test was going to be hard.

Most of the students had been concentrating on their revision. It was Bill who really wanted to pass German, according to the teacher. The class test was going to be hard.

Most of the students had been concentrating on their revision. Bill really wanted to pass German, according to the teacher. The class test was going to be hard.
Changes: (original) German to French (close) or Maths (distant)

2.

Everyone at the hotel was feeling very stressed out because of the delays. What Bruce took was a tablet to calm him down. Travelling isn't always as much fun as people say.

Everyone at the hotel was feeling very stressed out because of the delays. It was Bruce who took a tablet to calm him down. Travelling isn't always as much fun as people say.

Everyone at the hotel was feeling very stressed out because of the delays. Bruce took was a tablet to calm him down. Travelling isn't always as much fun as people say.
Changes: (original) tablet to capsule (close) or shower (distant)

3.
A group of friends meet up for a stag night. What Jamie really liked was the lager. Everyone had a good time at the pub.

A group of friends meet up for a stag night. It was Jamie who really liked the lager. Everyone had a good time at the pub.

A group of friends meet up for a stag night. Jamie really liked was the lager. Everyone had a good time at the pub.
Changes: (original) lager to beer (close) or music (distant)

4.
School children are taught domestic skills these days. What Richard liked was baking in Mrs Webster's class. Most of the children agreed it was better than geography.

School children are taught domestic skills these days. It was Richard who liked was baking in Mrs Webster's class. Most of the children agreed it was better than geography.

School children are taught domestic skills these days. Richard liked baking in Mrs Webster's class. Most of the children agreed it was better than geography.
Changes: (original) baking to cooking (close) or ironing (distant)

5.
Gerald made an Indian meal for all his flatmates. What Brian really liked was the beef. It took a great deal of time and effort to make the dishes.

Gerald made an Indian meal for all his flatmates. It was Brian who really liked the beef. It took a great deal of time and effort to make the dishes.

Gerald made an Indian meal for all his flatmates. Brian really liked the beef. It took a great deal of time and effort to make the dishes.
Changes: (original) beef to meat (close) or rice (distant)

6.
Miranda regretted serving red wine at the party. What Charles ruined was her blouse according to my friend. Apparently salt is useful for getting it out.

Miranda regretted serving red wine at the party. It was Charles who ruined her blouse according to my friend. Apparently salt is useful for getting it out.

Miranda regretted serving red wine at the party. Charles ruined her blouse according to my friend. Apparently salt is useful for getting it out.
Changes: (original) blouse to shirt (close) or chair (distant)

7.
A group of friends had been planning a camping trip for some time. What Janet refused to leave without was her rucksack, so the story goes. After a lot of preparation, they were finally ready to set off.

A group of friends had been planning a camping trip for some time. It was Janet who refused to leave without her rucksack, so the story goes. After a lot of preparation, they were finally ready to set off.

A group of friends had been planning a camping trip for some time. Janet refused to leave without her rucksack, so the story goes. After a lot of preparation, they were finally ready to set off.
Changes: (original) rucksack to backpack (close) or nailfile (distant)

8.
As a reward for good behaviour, the children were allowed to buy something new. What James bought were some new boots at the shopping mall. Everyone was pleased with their purchases.

As a reward for good behaviour, the children were allowed to buy something new. It was James who bought some new boots at the shopping mall. Everyone was pleased with their purchases.

As a reward for good behaviour, the children were allowed to buy something new. James bought some new boots at the shopping mall. Everyone was pleased with their purchases.
Changes: (original) boots to shoes (close) or toys (distant)

9.
It was payday, and some of the secretaries went shopping after work. What Maria chose was a new novel to take on holiday. They then decided to go to John Lewis.

It was payday, and some of the secretaries went shopping after work. It was Maria who chose a new novel to take on holiday. They then decided to go to John Lewis.

It was payday, and some of the secretaries went shopping after work. Maria chose a new novel to take on holiday. They then decided to go to John Lewis.
Changes: (original) novel to book (close) or dress (distant)

10.
It was always lovely to go on a country walk. What Sam saw was a toad in the millpond. Luckily the farmer was very friendly, and they were allowed to go anywhere.

It was always lovely to go on a country walk. It was Sam who saw a toad in the millpond. Luckily the farmer was very friendly, and they were allowed to go anywhere.

It was always lovely to go on a country walk. Sam saw a toad in the millpond. Luckily the farmer was very friendly, and they were allowed to go anywhere.
Changes: (original) toad to frog (close) or boat (distant)

11.
The Smiths were on holiday in the South of France. What Peter really missed was his mates at home. But everybody appreciated the break from normal life.

The Smiths were on holiday in the South of France. It was Peter who really missed his bed at home. But everybody appreciated the break from normal life.

The Smiths were on holiday in the South of France. Peter really missed his bed at home. But everybody appreciated the break from normal life.
Changes: (original) mates to pals (close) or bed (distant)

12.
The whole family was thinking of new things to do. What Sally decided to take up was painting as a hobby. Life at home was never boring.

The whole family was thinking of new things to do. It was Sally who decided to take up painting as a hobby. Life at home was never boring.

The whole family was thinking of new things to do. Sally decided to take up painting as a hobby. Life at home was never boring.
Changes: (original) painting to drawing (close) or swimming (distant)

13.
The filming of the Chippendales had begun at the studio. What Timothy took off was his sweater, without saying a word. They were all hoping for a profitable film.

The filming of the Chippendales had begun at the studio. It was Timothy who took off his sweater, without saying a word. They were all hoping for a profitable film.

The filming of the Chippendales had begun at the studio. Timothy took off his sweater, without saying a word. They were all hoping for a profitable film.
Changes: (original) sweater to jumper (close) or headset (distant)

14.
The MacDonald's had decided to go on holiday to Florida. What Sarah spotted was a crocodile in the distance. There was a lot to see in the boat trip to the everglades.

The MacDonald's had decided to go on holiday to Florida. It was Sarah who spotted a crocodile in the distance. There was a lot to see in the boat trip to the everglades.

The MacDonald's had decided to go on holiday to Florida. Sarah spotted a crocodile in the distance. There was a lot to see in the boat trip to the everglades.
Changes: (original) crocodile to alligator (close) or rainbow (distant)

15.
Mr and Mrs Newman had booked afternoon appointments at the dentist. What Roy was scared of was needles, the dentist remembered from last time. The waiting room was full of uneasy looking people.

Mr and Mrs Newman had booked afternoon appointments at the dentist. It was Roy who was scared of needles, the dentist remembered from last time. The waiting room was full of uneasy looking people.

Mr and Mrs Newman had booked afternoon appointments at the dentist. Roy was scared of needles, the dentist remembered from last time. The waiting room was full of uneasy looking people.
Changes: (original) needles to syringes (close) or fillings (distant)

16.
The play rehearsal was at four in the afternoon. What Lucy couldn't find was her shawl, and everybody was held up for half an hour. But the other actors were quite tolerant.

The play rehearsal was at four in the afternoon. It was Lucy who couldn't find her shawl, and everybody was held up for half an hour. But the other actors were quite tolerant.

The play rehearsal was at four in the afternoon. Lucy couldn't find her shawl, and everybody was held up for half an hour. But the other actors were quite tolerant.
Changes: (original) scarf to shawl (close) or script (distant)

17.
Everyone had just got back from a long and tiring swim in the sea. What Simon sat down on was the chair near the beach hut. The picnic lunch was very welcome.

Everyone had just got back from a long and tiring swim in the sea. It was Simon who sat down on the chair near the beach hut. The picnic lunch was very welcome.

Everyone had just got back from a long and tiring swim in the sea. Simon sat down on the chair near the beach hut. The picnic lunch was very welcome.
Changes: (original) chair to seat (close) or rock (distant)

18.
The students were told to write a twenty-page essay on Shakespeare. What Graeme used was a notepad for the assignment. Most of the students took a very long time to write it.

The students were told to write a twenty-page essay on Shakespeare. It was Graeme who used a notepad for the assignment. Most of the students took a very long time to write it.

The students were told to write a twenty-page essay on Shakespeare. Graeme used a notepad for the assignment. Most of the students took a very long time to write it.
Changes: (original) notepad to notebook (close) or laptop (distant)

19.
There was a landscape painting competition. What Stephen painted was a river behind a field. The first prize was to visit Picasso's birthplace.

There was a landscape painting competition. It was Stephen who painted a river behind a field. The first prize was to visit Picasso's birthplace.

There was a landscape painting competition. Stephen painted a river behind a field. The first prize was to visit Picasso's birthplace.
Changes: (original) river to stream (close) or house (distant)

20.
They came home late after a long night on the town. What Harry turned on was a light in the living room. They decided to have a nightcap before turning in for the night.

They came home late after a long night on the town. It was Harry who turned on a light in the living room. They decided to have a nightcap before turning in for the night.

They came home late after a long night on the town. Harry turned on a light in the living room. They decided to have a nightcap before turning in for the night.
Changes: (original) light to lamp (close) or radio (distant)

21.
There was a minor traffic accident on the high street. What Tony broke was his ankle when the car skidded into the wall. The incident was reported in the local press.

There was a minor traffic accident on the high street. It was Tony who broke his ankle when the car skidded into the wall. The incident was reported in the local press.

There was a minor traffic accident on the high street. Tony broke his ankle when the car skidded into the wall. The incident was reported in the local press.
Changes: (original) ankle to foot (close) or watch (distant)

22.
The birthday party was great fun. What Michael really enjoyed was the cake at the end of the party. There were about twenty noisy children running around.

The birthday party was great fun. It was Michael who really enjoyed the game at the end of the party. There were about twenty noisy children running around.

The birthday party was great fun. Michael really enjoyed the game at the end of the party. There were about twenty noisy children running around.
Changes: (original) cake/ to food (close) or game (distant)

23.
It had been a long day in the office. What Anne put down was her pen as she got ready to go home. Everyone was glad the weekend was coming.

It had been a long day in the office. It was Anne who put down her pen as she got ready to go home. Everyone was glad the weekend was coming.

It had been a long day in the office. Anne put down her pen as she got ready to go home. Everyone was glad the weekend was coming.
Changes: (original) pen to biro (close) or bag (distant)

24.
They went back to the vet's surgery on the street corner. What Alison collected was her gerbil at the reception. There was a strange antiseptic smell.

They went back to the vet's surgery on the street corner. It was Alison who collected her gerbil at the reception. There was a strange antiseptic smell.

They went back to the vet's surgery on the street corner. Alison collected her gerbil at the reception. There was a strange antiseptic smell.
Changes: (original) gerbil to hamster (close) or wages (distant)

Experiment 4 – Focus (focus, anti-focus and baseline) delayed probe recognition

1.
Most of the students had been concentrating on their revision. What Bill really wanted to pass was German, according to the teacher. The class test was going to be hard.

Most of the students had been concentrating on their revision. It was Bill who really wanted to pass German, according to the teacher. The class test was going to be hard.

Most of the students had been concentrating on their revision. Bill really wanted to pass German, according to the teacher. The class test was going to be hard.
Probe: German

2.
Everyone at the hotel was feeling very stressed out because of the delays. What Bruce took was a tablet to calm him down. Travelling isn't always as much fun as people say.

Everyone at the hotel was feeling very stressed out because of the delays. It was Bruce who took a tablet to calm him down. Travelling isn't always as much fun as people say.

Everyone at the hotel was feeling very stressed out because of the delays. Bruce took was a tablet to calm him down. Travelling isn't always as much fun as people say.
Probe: tablet

3.
A group of friends meet up for a stag night. What Jamie really liked was the lager. Everyone had a good time at the pub.

A group of friends meet up for a stag night. It was Jamie who really liked the lager. Everyone had a good time at the pub.

A group of friends meet up for a stag night. Jamie really liked was the lager. Everyone had a good time at the pub.
Probe: lager

4.
School children are taught domestic skills these days. What Richard liked was baking in Mrs Webster's class. Most of the children agreed it was better than geography.

School children are taught domestic skills these days. It was Richard who liked baking in Mrs Webster's class. Most of the children agreed it was better than geography.

School children are taught domestic skills these days. Richard liked baking in Mrs Webster's class. Most of the children agreed it was better than geography.
Probe: baking

5.
Gerald made an Indian meal for all his flatmates. What Brian really liked was the beef. It took a great deal of time and effort to make the dishes.

Gerald made an Indian meal for all his flatmates. It was Brian who really liked the beef. It took a great deal of time and effort to make the dishes.

Gerald made an Indian meal for all his flatmates. Brian really liked the beef. It took a great deal of time and effort to make the dishes.
Probe: beef

6.
Miranda regretted serving red wine at the party. What Charles ruined was her blouse according to my friend. Apparently salt is useful for getting it out.

Miranda regretted serving red wine at the party. It was Charles who ruined her blouse according to my friend. Apparently salt is useful for getting it out.

Miranda regretted serving red wine at the party. Charles ruined her blouse according to my friend. Apparently salt is useful for getting it out.
Probe: blouse

7.
A group of friends had been planning a camping trip for some time. What Janet refused to leave without was her rucksack, so the story goes. They were finally ready to set off.

A group of friends had been planning a camping trip for some time. It was Janet who refused to leave without her rucksack, so the story goes. They were finally ready to set off.

A group of friends had been planning a camping trip for some time. Janet refused to leave without her rucksack, so the story goes. They were finally ready to set off.
Probe: rucksack

8.
As a reward for good behaviour, the children were allowed to buy something new. What James bought were some new boots at the shopping mall. Everyone was pleased with their purchases.

As a reward for good behaviour, the children were allowed to buy something new. It was James who bought some new boots at the shopping mall. Everyone was pleased with their purchases.

As a reward for good behaviour, the children were allowed to buy something new. James bought some new boots at the shopping mall. Everyone was pleased with their purchases.
Probe: boots

9.
It was payday, and some of the secretaries went shopping after work. What Maria chose was a new novel to take on holiday. They then decided to go to John Lewis.

It was payday, and some of the secretaries went shopping after work. It was Maria who chose a new novel to take on holiday. They then decided to go to John Lewis.

It was payday, and some of the secretaries went shopping after work. Maria chose a new novel to take on holiday. They then decided to go to John Lewis.

Probe: novel

10.
It was always lovely to go on a country walk. What Sam saw was a toad in the millpond. Luckily the farmer was very friendly, and they were allowed to go anywhere.

It was always lovely to go on a country walk. It was Sam who saw a toad in the millpond. Luckily the farmer was very friendly, and they were allowed to go anywhere.

It was always lovely to go on a country walk. Sam saw a toad in the millpond. Luckily the farmer was very friendly, and they were allowed to go anywhere.
Probe: toad

11.
The Smiths were on holiday in the South of France. What Peter really missed was his bed at home. But everybody appreciated the break from normal life.

The Smiths were on holiday in the South of France. It was Peter who really missed his bed at home. But everybody appreciated the break from normal life.

The Smiths were on holiday in the South of France. Peter really missed his bed at home. But everybody appreciated the break from normal life.
Probe: bed

12.
The whole family was thinking of new things to do. What Sally decided to take up was painting as a hobby. Life at home was never boring.

The whole family was thinking of new things to do. It was Sally who decided to take up painting as a hobby. Life at home was never boring.

The whole family was thinking of new things to do. Sally decided to take up painting as a hobby. Life at home was never boring.
Probe: painting

13.
The filming of the Chippendales had begun at the studio. What Timothy took off was his sweater, without saying a word. They were all hoping for a profitable film.

The filming of the Chippendales had begun at the studio. It was Timothy who took off his sweater, without saying a word. They were all hoping for a profitable film.

The filming of the Chippendales had begun at the studio. Timothy took off his sweater, without saying a word. They were all hoping for a profitable film.
Probe: sweater

14.
The MacDonald's had decided to go on holiday to Florida. What Sarah spotted was a rainbow in the distance. There was a lot to see in the boat trip to the everglades.

The MacDonald's had decided to go on holiday to Florida. It was Sarah who spotted a rainbow in the distance. There was a lot to see in the boat trip to the everglades.

The MacDonald's had decided to go on holiday to Florida. Sarah spotted a rainbow in the distance. There was a lot to see in the boat trip to the everglades.
Probe: rainbow

15.
The Newman's had booked afternoon appointments at the dentist. What Roy was scared of was fillings, the dentist remembered from last time. The waiting room was full of uneasy looking people.

The Newman's had booked afternoon appointments at the dentist. It was Roy who was scared of fillings, the dentist remembered from last time. The waiting room was full of uneasy looking people.

The Newman's had booked afternoon appointments at the dentist. Roy was scared of fillings, the dentist remembered from last time. The waiting room was full of uneasy looking people.
Probe: fillings

16.
The play rehearsal was at four in the afternoon. What Lucy couldn't find was her shawl, and everybody was held up for half an hour. But the other actors were quite tolerant.

The play rehearsal was at four in the afternoon. It was Lucy who couldn't find her shawl, and everybody was held up for half an hour. But the other actors were quite tolerant.

The play rehearsal was at four in the afternoon. Lucy couldn't find her shawl, and everybody was held up for half an hour. But the other actors were quite tolerant.
Probe: shawl

17.
Everyone had just got back from a long and tiring swim in the sea. What Simon sat down on was the chair near the beach hut. The picnic lunch was very welcome.

Everyone had just got back from a long and tiring swim in the sea. It was Simon who sat down on the chair near the beach hut. The picnic lunch was very welcome.

Everyone had just got back from a long and tiring swim in the sea. Simon sat down on the chair near the beach hut. The picnic lunch was very welcome.
Probe: chair

18.
The students were told to write a twenty-page essay on Shakespeare. What Graeme used was a notepad for the assignment. Most of the students took a very long time to write it.

The students were told to write a twenty-page essay on Shakespeare. It was Graeme who used a notepad for the assignment. Most of the students took a very long time to write it.

The students were told to write a twenty-page essay on Shakespeare. Graeme used a notepad for the assignment. Most of the students took a very long time to write it.
Probe: notepad

19.
There was a landscape painting competition. What Stephen painted was a river behind a field. The first prize was to visit Picasso's birthplace.

There was a landscape painting competition. It was Stephen who painted a river behind a field. The first prize was to visit Picasso's birthplace.

There was a landscape painting competition. Stephen painted a river behind a field. The first prize was to visit Picasso's birthplace.
Probe: river

20.
They came home late after a long night on the town. What Harry turned on was a light in the living room. They decided to have a nightcap before turning in for the night.

They came home late after a long night on the town. It was Harry who turned on a light in the living room. They decided to have a nightcap before turning in for the night.

They came home late after a long night on the town. Harry turned on a light in the living room. They decided to have a nightcap before turning in for the night.
Probe: light

21.
There was a minor traffic accident on the high street. What Tony broke was his ankle when the car skidded into the wall. The incident was reported in the local press.

There was a minor traffic accident on the high street. It was Tony who broke his ankle when the car skidded into the wall. The incident was reported in the local press.

There was a minor traffic accident on the high street. Tony broke his ankle when the car skidded into the wall. The incident was reported in the local press.
Probe: ankle

22.
The birthday party was great fun. What Michael really enjoyed was the game at the end of the party. There were about twenty noisy children running around.

The birthday party was great fun. It was Michael who really enjoyed the game at the end of the party. There were about twenty noisy children running around.

The birthday party was great fun. Michael really enjoyed the game at the end of the party. There were about twenty noisy children running around.
Probe: game

23.
It had been a long day in the office. What Anne put down was her biro as she got ready to go home. Everyone was glad the weekend was coming.

It had been a long day in the office. It was Anne who put down her biro as she got ready to go home. Everyone was glad the weekend was coming.

It had been a long day in the office. Anne put down her biro as she got ready to go home. Everyone was glad the weekend was coming.
Probe: biro

24.
They went back to the vet's surgery on the street corner. What Alison collected was her gerbil at the reception. There was a strange antiseptic smell.

They went back to the vet's surgery on the street corner. It was Alison who collected her gerbil at the reception. There was a strange antiseptic smell.

They went back to the vet's surgery on the street corner. Alison collected her gerbil at the reception. There was a strange antiseptic smell.
Probe: gerbil

25.
There are usually great sales on when summer draws to an end. What Laura wanted was a new dress to wear. Finding a bargain is always fun.

There are usually great sales on when summer draws to an end. It was Laura who wanted a new dress to wear. Finding a bargain is always fun.

There are usually great sales on when summer draws to an end. Laura wanted a new dress to wear. Finding a bargain is always fun.
Probe: dress

26.
Everyone was looking forward to their Christmas bonus. What Joanne really wanted was a promotion this year. It had been a very busy year.

Everyone was looking forward to their Christmas bonus. It was Joanne who really wanted a promotion this year. It had been a very busy year.

Everyone was looking forward to their Christmas bonus. Joanne really wanted a promotion. It had been a very busy year.
Probe: promotion

27.
Everybody didn't like the atmosphere in the new office. What Joe wanted was a new job somewhere else. It would be nice to have a change of scenery.

Everybody didn't like the atmosphere in the new office. It was Joe who wanted a new job somewhere else. It would be nice to have a change of scenery.

Everybody didn't like the atmosphere in the new office. Joe wanted a new job somewhere else. It would be nice to have a change of scenery.
Probe: job

28.
Everyone got soaked coming into work this morning. What Paul really wanted was his trousers to dry. It was such a miserable day.

Everyone got soaked coming into work this morning. It was Paul who really wanted his trousers to dry. It was such a miserable day.

Everyone got soaked coming into work this morning. Paul really wanted his trousers to dry. It was such a miserable day.
Probe: trousers

29.
Office politics can make people's working life difficult. What Tom wanted was whiskey when he got home. It had been a very stressful day.

Office politics can make people's working life difficult. It was Tom who wanted whiskey when he got home. It had been a very stressful day.

Office politics can make people's working life difficult. Tom wanted whiskey when he got home. It had been a very stressful day.
Probe: whiskey

30.
Dining out can be fun for the whole family. What Harry enjoyed eating was the cake.
The restaurant catered for small children.

Dining out can be fun for the whole family. It was Harry who enjoyed eating the cake.
The restaurant catered for small children.

Dining out can be fun for the whole family. Harry enjoyed eating the cake. The
restaurant catered for small children.
Probe: cake

31.
Some people can be very forgetful. What Jake forgot was his keys this morning. Being
locked out of your house isn't fun.

Some people can be very forgetful. It was Jake who forgot his keys this morning. Being
locked out of your house isn't fun.

Some people can be very forgetful. Jake forgot his keys this morning. Being locked out
of your house isn't fun.
Probe: keys

32.
Weddings are such special occasions for the whole family to enjoy. What Jessica really
enjoys was drinking the champagne at the reception. It had been a lovely day.

Weddings are such special occasions for the whole family to enjoy. It was Jessica who
really enjoys drinking the champagne at the reception. It had been a lovely day.

Weddings are such special occasions for the whole family to enjoy. Jessica really enjoys
drinking the champagne at the reception. It had been a lovely day.
Probe: champagne

33.
Going shopping in the supermarket can be stressful. What Lucinda lost was her purse,
she left had it on the bus. The queue at till was getting very long.

Going shopping in the supermarket can be stressful. It was Lucinda who lost her purse,
she had left it on the bus. The queue at till was getting very long.

Going shopping in the supermarket can be stressful. Lucinda lost her purse, she had left
it on the bus. The queue at till was getting very long.
Probe: purse

34.
It is important to get advice when purchasing new office equipment. What Linda wanted was a new computer with a thin screen. Technology has improved a lot these days.

It is important to get advice when purchasing new office equipment. It was Linda who wanted a new computer with a thin screen. Technology has improved a lot these days.

It is important to get advice when purchasing new office equipment. Linda wanted a new computer with a thin screen. Technology has improved a lot these days.
Probe: computer

35.
There are usually great New Year sales. What Jeremy wanted was a new suit to wear. It is important to buy good quality clothing.

There are usually great New Year sales. It was Jeremy who wanted a new suit to wear. It is important to buy good quality clothing.

There are usually great New Year sales. Jeremy wanted a new suit to wear. It is important to buy good quality clothing.
Probe: suit

36.
Everybody at school was running about with anticipation. What David was excited about was his holiday in Italy. At last it was the final day of school.

Everybody at school was running about with anticipation. It was David who was excited about his holiday in Italy. At last it was the final day of school.

Everybody at school was running about with anticipation. David was excited about his holiday in Italy. At last it was the final day of school.
Probe: holiday

Experiment 5 – Subordination (Main vs. Subordinate) sentence continuation
1.
Lee put the kettle on after/before Karen came home.
After/Before Karen came home, Lee put the kettle on.

 2.
Jackie rang the cinema after/before Philip went to the pub.
After/Before Philip went to the pub, Jackie rang the cinema.

3.
Jim filled in the betting slip after/before Gina bought the newspaper.
After/Before Gina bought the newspaper, Jim filled in the betting slip.

4.
Julie chatted on her phone after/before Roger bought his book.
After/Before Roger bought his book, Julie chatted on her phone.

5.
Meg started on the ironing after/before Clive arrived back from work.
After/Before Clive arrived back from work, Meg started on the ironing.

6.
Frank rang the box office after/before Isabel cooked the dinner.
After/Before Isabel cooked the dinner, Frank rang the box office.

7.
Ron put on her shoes after/before Jennifer finished her coffee.
After/Before Jennifer finished her coffee, Ron put on her shoes.

8.
Joan rang the train station after/before Tim started his tennis game.
After/Before Tim started his tennis game, Joan rang the train station.

9.
Danielle made the lunch after/before Gary cleaned his boots.
After/Before Gary cleaned his boots, Danielle made the lunch.

10.
Michelle put the video on after/before Ian went for a swim.
After/Before Ian went for a swim, Michelle put the video on.

11.
Brian went for a run after/before Andrea went to the bank.
After/Before Andrea went to the bank, Brian went for a run.

12.
Chris left for work after/before Gill picked up the mail.
 After/Before Gill picked up the mail, Chris left for work.

13.
Alison finished reading her book after/before Alan took the bins out.
After/Before Alan took the bins out, Alison finished her book.

14.
Sid finished his tea after/before Sandy left her keys behind.
After/Before Sandy left her keys behind, Sid finished his tea.

15.
Andrew went to the library after/before Angela made her sandwich.

After/Before Angela made her sandwich, Andrew went to the library.

16.
Anne tidied the bathroom after/before Jim finished painting the hall.
After/Before Jim finished painting the hall, Anne tidied the bathroom.

17.
Jack ate the cheese after/before Paula read her book.
After/Before Paula read her book, Jack ate the cheese.

18.
After/Before Henry crashed the car, Sharon walked home.
Sharon walked home after/before Henry crashed the car.

19.
Tom put his kilt on after/before Harriet opened her eyes.
After/Before Harriet opened her eyes, Tom put his kilt on.

20.
After/Before Anthony went hill walking, Jessica went for a drive.
Jessica went for a drive after/before Anthony went hill walking.

21.
Harry bought a new hat after/before Joanne got a promotion.
After/Before Joanne got a promotion, Harry bought a new hat.

22.
After/Before Joe got a new job, Laura got new shoes.
Laura got new shoes after/before Joe got a new job.

23.
Paul bought new gloves after/before Lauren got out of bed.
After/Before Lauren got out of bed, Paul bought new gloves.

24.
After/Before Simon went to the toilet, Katie made breakfast.
Katie made breakfast after/before Simon went to the toilet.

Experiment 6 – Subordination (Main vs. Subordinate) self-paced reading
1.
There was a murder committed at a hotel recently. The private detective investigated the scene of the crime after the receptionist phoned the authorities.

There was a murder committed at a hotel recently. After the receptionist phoned the authorities, the private detective investigated the scene of the crime.
Target sentence: He/she was shocked by the whole thing.

2.
The newspaper report had information about an incident at sea. A woman tried to hijack the boat after the captain had a severe stroke.

The newspaper report had information about an incident at sea. After the captain had a severe stroke, a woman tried to hijack the boat.
Target sentence: She/he had started to panic.

3.
The two lovers had been living together for nearly a year. John booked the cinema tickets after Mary finished work.

The two lovers had been living together for nearly a year. After Mary finished work, John booked the cinema tickets.
Target sentence: She/He wanted to see the new western.

4.
It is important to demand high standards of hygiene in a busy restaurant. Gordon prepared the pudding after Tanya washed down the table.

It is important to demand high standards of hygiene in a busy restaurant. After Tanya washed down the table, Gordon prepared the pudding.
Target sentence: She/he made sure the health regulations were followed to the letter.

5.
There has been a major accident on the M74. The nurse soothed the crash victims after the doctor had dressed their wounds.

There has been a major accident on the M74. After the doctor had dressed their wounds, the nurse soothed the crash victims.
Target sentence: He/she were kept very busy dealing with the aftermath.

6.
There was a dinner party to celebrate a new job. Harry tasted the ice cream to make sure it was frozen properly after Yvonne had served the main course.

There was a dinner party to celebrate a new job. After Yvonne had served the main course, Harry tasted the ice cream to make sure it was frozen properly.
Target sentence: She/he thought the evening was lovely.

7.
Keeping control over children is an important thing to do. The little boy had a tantrum after Molly refused to buy any sweeties.

Keeping control over children is an important thing to do. After Molly refused to buy any sweeties, the little boy had a tantrum.

Target sentence: He/she felt very tired afterwards.

8.
Someone was needed to deliver papers to the downtown area. The papergirl finished her rounds after the newsagent ate his breakfast.

Someone was needed to deliver papers to the downtown area. After the newsagent ate his breakfast, the papergirl completed her rounds.
Target sentence: He/she didn't mind getting up early.

9.
The north side of the island had some long, sandy beaches. Jenny went for a stroll along the beach after Andy made breakfast.

The north side of the island had some long, sandy beaches. After Andy made breakfast, Jenny went for a stroll along the beach.
Target sentence: He/she felt very relaxed.

10.
Keeping the place tidy is important; cleanliness is next to godliness. Mr Jones left for work after the cleaner hoovered the carpet.

Keeping the place tidy is important; cleanliness is next to godliness.   After the cleaner hoovered the carpet, Mr Jones left for work.
Target sentence: She/he took pride in their work.

11.
Both the school drama club and the music society were involved in a new production. The headmaster decided he liked the new play before the teacher added the music.

Both the school drama club and the music society were involved in a new production. Before the teacher added the music, the headmaster decided he liked the new play.
Target sentence: He/she thought it was bound to be a success.

12.
At the research institute, everything was to be kept tidy. The scientist put the research report in the filing cabinet before the secretary arrived.

At the research institute, everything was to be kept tidy. Before the secretary arrived, the scientist put the research report in the filing cabinet.
Target sentence: He/she had a busy day in front of them.

13.
The filming of the fight scene was going very well. The cowboy fired his gun before the Indian squaw threw her tomahawk.

The filming of the fight scene was going very well. Before the Indian Squaw threw her tomahawk, the cowboy fired his gun.
Target sentence: He/she hoped the film would be a success.

14.
The auditions were nerve wracking for the hopeful stars. The actress learnt her script before there was a meeting with the director.

The auditions were nerve wracking for the hopeful stars. Before there was a meeting with the director, the actress learnt her script.
 Target sentence: She/he liked to be prepared for anything.

15.
The political meeting was a bit of a shambles. The spokeswoman suggested her idea before the man stepped onto the stage.

The political meeting was a bit of a shambles. Before the man stepped onto the stage, the spokeswoman suggested her idea.
Target sentence: She/he should have discussed it privately when the meeting ended.

16.
It is very important to plan a dinner party in advance. The woman started cooking before her husband arrived with the food.

It is very important to plan a dinner party in advance. Before her husband arrived with the food, the woman starting cooking.
Target sentence: She/he was running ahead of schedule

17.
It is best when husbands and wives agree on how to do things. Mrs Jones bought the new Mercedes before Mr Jones discussed the finances.

It is best when husbands and wives agree on how to do things. Before Mrs Jones bought the new Mercedes, Mr Jones discussed the finances.
Target sentence: She/he usually discusses important decisions.

18.
The Christmas period was approaching and people liked to be organised. Susan bought her Christmas presents after Ross sent out their Christmas cards.

The Christmas period was approaching and people liked to be organised. After Ross sent out their Christmas cards, Susan bought her Christmas presents.
Target sentence: She/he made sure no-one was forgotten.

19.
It is important to take an interest in local wildlife and conservation. Bill filled the bird feeders after Emma ate her breakfast.

It is important to take an interest in local wildlife and conservation. After Emma ate her breakfast, Bill filled the bird feeders. He/she was a keen bird watcher.
Target sentence: He/she was a keen bird watcher.

20.
Record numbers of people voted in this year's election.   Martha started dinner after Robbie went to the local polling station.

Record numbers of people voted in this year's election.   After Robbie went to the polling station, Martha started dinner.
Target sentence: She/he always votes at the local polling station.

21.
Music is a medium which is heard all over the world. Meg felt she danced for hours after James cooked a romantic dinner.

Music is a medium which is heard all over the world. After James cooked a romantic dinner, Meg felt she danced for hours.
Target sentence: He/she had a wonderful anniversary.

22.
Lack of exercise is a growing concern with children: obesity rated have dramatically increased. The principal demanded exercise everyday before the pupil ate lunch.

Lack of exercise is a growing concern with children: obesity rates have dramatically increased. Before the pupil ate lunch, the principal demanded exercise everyday.
Target sentence: He/she benefited from this regime.

23.
To climb Mount Everest would fulfil a lifelong dream. Sarah mapped out the route before Albert said his goodbyes to his family.

To climb Mount Everest would fulfil a lifelong dream.
Before Albert said his goodbyes to his family, Sarah mapped out the route.
Target sentence: He/she had wanted to do this for years.

24.
The Olympics are the pinnacle of any athlete's career. Sally fired the starter gun before Colin was ready.

The Olympics are the pinnacle of any athlete's career. Before Colin was ready, sally fired the starter gun.

Target sentence: He/she took sports very seriously.

25.
All the applicants for the accountant's job were extremely nervous as they sat waiting for their interviews. Jeremy tried to relax before Pamela started the interview.

All the applicants for the accountant's job were extremely nervous as they sat waiting for their interviews. Before Pamela started the interview, Jeremy tried to relax.
Target sentence: He/she was looking forward to the end of today.

26.
There was a horrific car crash during rush hour this morning. The young policeman assessed the situation after the injured woman was on her way to hospital.

There was a horrific car crash during rush hour this morning. After the injured woman was on her way to hospital, the young policeman assessed the situation.
Target sentence: He/she was mentioned in the press.

27.
Every Halloween the Williams family has a party. Stephanie got dressed up before Charlie put all the decorations up.

Every Halloween the Williams family has a party. Before Charlie put all the decorations up, Stephanie got dressed up.
Target sentence: He/she likes telling ghost stories.

28.
The annual regatta gala was the town's biggest social event of the year. The Mayor gave a lengthy welcome before the duchess sat down to a three course meal.

The annual regatta gala was the town's biggest social event of the year. Before the duchess sat down to a three course meal, the Mayor gave a lengthy welcome.
Target sentence: He/she was impressed by the turnout.

29.
Trying to catch a taxi at peak time in New York is almost impossible. Adam hailed a cab after Samantha went shopping on Fifth Avenue.

Trying to catch a taxi at peak time in New York is almost impossible. After Samantha went shopping on Fifth Avenue, Adam hailed a cab.
Target sentence: She/he loved New York.

30.
The picnic once a week was always a great success. Charlotte laid out the picnic before Freddie fed the ducks.

The picnic once a week was always a great success. Before Freddie fed the ducks, Charlotte laid out the picnic.
Target sentence: She/he had a lovely afternoon.

31.
It was Christmas Day and for the first time in years it was snowing heavily. Harry made a snowman before mum made the Christmas dinner.

It was Christmas day and for the first time in years it was snowing heavily. Before mum made the Christmas dinner, Harry made a snowman.
Target sentence: He/she loves the festive period.

32.
It is fundamental to the museum curator to ensure all displays are historically accurate. Mrs Hislop finished the display before the Duke of Edinburgh visited the museum.

It is fundamental to the museum curator to ensure all displays are historically accurate. Before the Duke of Edinburgh visited the museum, Mrs Hislop finished the display.
Target sentence: He/she loves spending time in the museum.

Experiment 7 – Subordination (Main vs. Subordinate) delayed probe recognition
1.
There was a murder committed at a hotel recently. The private detective found the knife on the floor after the receptionist found the body in the hall. They were shocked by the whole situation.

There was a murder committed at a hotel recently. After the receptionist found the body in the hall, the private detective found the knife on the floor. They were shocked by the whole situation.
Probe: knife or body

2.
The newspaper report had information about an incident at sea. A woman tried to hijack the boat in the harbour after the captain lost the anchor in the sea. They had started to panic.

The newspaper report had information about an incident at sea. After the captain lost the anchor in the sea, a woman tried to hijack the boat in the harbour. They had started to panic.
Probe: boat or anchor

3.
The two lovers had been living together for nearly a year. John booked the cinema tickets that night after Mary finished doing the dishes quickly. They wanted to see the new western.

The two lovers had been living together for nearly a year. After Mary finished doing the dishes quickly, John booked the cinema tickets that night. They wanted to see the new western.
Probe: tickets or dishes

4.
It is important to demand high standards of hygiene in a busy restaurant. Gordon prepared the meat for the meal after Tanya washed down the table by the door. They make sure health regulations are followed.

It is important to demand high standards of hygiene in a busy restaurant. After Tanya washed down the table by the door, Gordon prepared the meat for the meal. They make sure health regulations are followed.
Probe: table or meat

5.
There has been a major accident on the M74. The nurse opened the ambulance doors quickly after the doctor had packed his kit in his bag. They were kept very busy dealing with the aftermath.

There has been a major accident on the M74. After the doctor had packed his kit in his bag, the nurse opened the doors quickly. They were kept very busy dealing with the aftermath.
Probe: kit or doors

6.
There was a dinner party to celebrate a new job. Harry tasted the dessert to make sure it was frozen properly after Yvonne had served the main course to the guests. They thought the evening was lovely.

There was a dinner party to celebrate a new job. After Yvonne had served the main course to the guests, Harry tasted the dessert to make sure it was frozen properly. They thought the evening was lovely.
Probe: dessert or course

7.
Keeping control over children is an important thing to do. The little boy broke his toy train after Molly refused to buy any sweets from the shop. They both felt very grumpy by the afternoon.

Keeping control over children is an important thing to do. After Molly refused to buy any sweets, the little boy broke his toy train. They both felt very grumpy by the afternoon.
Probe: toy or sweets

8.
Someone was needed to deliver papers to the downtown area. The papergirl finished her rounds slowly after the newsagent ate his toast with jam. They didn't mind getting up early.

Someone was needed to deliver papers to the downtown area. After the newsagent ate his toast with jam, the papergirl finished her rounds slowly. They didn't mind getting up early.
Probe: rounds or toast

9.
The north side of the island had some long, sandy beaches. Jenny went for a stroll along the beach that afternoon after Andy made lunch for two. They felt very relaxed as it had been a lovely day.

The north side of the island had some long, sandy beaches. After Andy made lunch for two, Jenny went for a stroll along the beach that afternoon. They felt very relaxed as it had been a lovely day.
Probe: beach or lunch

10.
Keeping the place tidy is important; cleanliness is next to godliness. Mr Jones left for work late after the cleaner hoovered the carpet downstairs. They like to be kept busy.

Keeping the place tidy is important; cleanliness is next to godliness. After the cleaner hoovered the carpet downstairs, Mr Jones left for work late. They like to be kept busy.
Probe: work or carpet

11.
For wise people, keeping fit is a major part of modern life. John ate his tea quickly before Rachel went to the gym down the road. They both believe it is important to keep in shape.

For wise people, keeping fit is a major part of modern life. Before Rachel went to the gym down the road, John ate his tea quickly. They both believe it is important to keep in shape.
Probe: tea or gym

12.
Both the school drama club and the music society were involved in a new production. The headmaster decided he liked the new play as it is before the teacher added the music to the finale. They think it is bound to be a success.

Both the school drama club and the music society were involved in a new production. Before the teacher added the music to the finale, the headmaster decided he liked the new play as it is. They think it is bound to be a success.

Probe: play or music

13.
At the research institute, everything was to be kept tidy. The scientist put the report in the filing cabinet before the secretary took her jacket off. They were going to be very busy all day.

At the research institute, everything was to be kept tidy. Before the secretary took her jacket off, the scientist put the report in the filing cabinet. They were going to be very busy all day.
Probe: report or jacket

14.
The filming of the fight scene was going very well. The cowboy fired his gun in the air before the Indian squaw threw her tomahawk into the tree. They hoped the film would be a huge success.

The filming of the fight scene was going very well. Before the Indian squaw threw her tomahawk into the tree, the cowboy fired his gun in the air. They hoped the film would be a huge success.
Probe: gun or tomahawk

15.
The auditions were nerve wracking for the hopeful stars. The actress learnt her script thoroughly before the director had his coffee with milk. They both just wanted today to be over.

The auditions were nerve wracking for the hopeful stars. Before the director had his coffee with milk, the actress learnt her script thoroughly. They both just wanted today to be over.
Probe: script or coffee

16.
It is very important to plan a dinner party in advance. Francesca turned the oven on before Gary arrived with the food for the party. They were almost running ahead of schedule.

It is very important to plan a dinner party in advance. Before Gary arrived with the food for the party, Francesca turned the oven on. They were almost running ahead of schedule.
Probe: oven or food

17.
It is best when husbands and wives agree on how to do things. Mrs Jones bought the new car that day before Mr Jones talked about the cash situation. Thankfully, it was an amazing deal.

It is best when husbands and wives agree on how to do things. Before Mr Jones talked about the cash situation, Mrs Jones bought the new car that day. Thankfully, it was an amazing deal.
Probe: car or cash

18.
The Christmas period was approaching and people liked to be organised. Susan bought her Christmas presents that afternoon after Ross sent out their Christmas cards that morning. They made sure no-one was forgotten.

The Christmas period was approaching and people liked to be organized. After Ross sent out their Christmas cards that morning,, Susan bought her Christmas presents that afternoon. They made sure no-one was forgotten.
Probe: presents or cards

19.
It is important to take an interest in local wildlife and conservation. Bill filled the bird table in the garden after Emma ate her breakfast slowly. They are both a keen bird watchers.

It is important to take an interest in local wildlife and conservation. After Emma ate her toast slowly, Bill filled the bird table. They are both a keen bird watchers.
Probe: breakfast or bird

20.
Record numbers of people voted in this year's election. Martha started making the soup for lunch after Robbie went to the local polling station. They hoped the right person would win.

Record numbers of people voted in this year's election.   After Robbie went to the local polling station, Martha started making the soup for lunch. They hoped the right person would win.
Probe: local or soup

21.
To climb Mount Everest would fulfill a lifelong dream. Sarah mapped out the route on the map before Albert said his goodbyes to his family. They had wanted to do this for years.

To climb Mount Everest would fulfill a lifelong dream. Before Albert said his goodbyes to his family, Sarah mapped out the route on the map. They had wanted to do this for years.
Probe: goodbyes or route

22.
The Olympics are the pinnacle of any athlete's career. Sally fired the starter gun, before Colin tied his running shoes. They took sports very seriously.

The Olympics are the pinnacle of any athlete's career. Before Colin tied his running shoes, sally fired the starter gun. They took sports very seriously.
Probe: running or starter

23.
All the applicants for the accountant's job were extremely nervous as they sat waiting for their interviews. Before Pamela picked up her pen on the table, Jeremy adjusted his tie quickly. They were looking forward to the end of today.

All the applicants for the accountant's job were extremely nervous as they sat waiting for their interviews. Jeremy adjusted his tie quickly before Pamela picked up her pen on the table. They were looking forward to the end of today.
Probe: pen or tie

24.
There was a horrific car crash during rush hour this morning. After the injured woman was on her way to hospital, the young policeman checked the damaged van on the road. They were mentioned in the press.

There was a horrific car crash during rush hour this morning. The young policeman checked the damaged van on the road, after the injured woman was on her way to hospital. They were mentioned in the press.
Probe: way or van

25.
Every Halloween the Williams family has a party. Stephanie put her costume on before Charlie put all the decorations up. They love telling scary ghost stories.

Every Halloween the Williams family has a party. Before Charlie put all the decorations up, Stephanie put her costume on. They love telling scary ghost stories.
Probe: decorations or costume

26.
Music is a medium that is heard all over the world. Meg opened a bottle of wine after James cooked a romantic meal with care. They had such a wonderful anniversary.

Music is a medium that is heard all over the world. After James cooked a romantic meal with care, Meg opened a bottle of wine. They had such a wonderful anniversary.
Probe: meal or wine

27.
The annual regatta gala was the town's biggest social event of the year. The Mayor gave a lengthy welcome speech, before the duchess sat down to a three course banquet. They were impressed by the turnout.

The annual regatta gala was the town's biggest social event of the year. Before the duchess sat down to a three course banquet, the Mayor gave a lengthy welcome speech. They were impressed by the turnout.
Probe: course or welcome

28.
Trying to catch a taxi at peak time in New York is almost impossible. Adam hailed a cab on the corner after Samantha went shopping for a hat on Fifth Avenue. They loved to spend a long weekend in New York.

Trying to catch a taxi at peak time in New York is almost impossible. After Samantha went shopping for a hat on Fifth Avenue, Adam hailed a cab on the corner. They loved to spend a long weekend in New York.
Probe: hat or cab

29.
The picnic once a week was always a great success. Charlotte laid out the picnic on the grass before Freddie fed the ducks some bread. They had such a lovely afternoon.

The picnic once a week was always a great success. Before Freddie fed the ducks some bread, Charlotte laid out the picnic on the grass. They had such a lovely afternoon.
Probe: picnic or ducks

30.
Buying a first home can be very nerve wracking. Mr Hendry discussed how much money was available before Mrs Hendry viewed any houses to buy. They were very excited about it.

Buying a first home can be very nerve wracking. Before Mrs Hendry viewed any houses to buy, Mr Hendry discussed how much money was available. They were very excited about it.
Probe: houses or money

31.
It was Christmas day and for the first time in years it was snowing heavily. Harry made a snowman in the garden before mum made the Christmas pudding with raisons.   They love it when it snows in winter.

It was Christmas day and for the first time in years it was snowing heavily. Before mum made the Christmas pudding with raisons, Harry made a snowman in the garden.   They love it when it snows in winter.

Probe: snowman or pudding

32.
Making sure all the final touches are made before a royal visit it important. Mrs Hislop finished the bicycle exhibit before the Duke of Edinburgh visited the transport museum. Its better when important events go smoothly.

Making sure all the final touches are made before a royal visit it important. Before the Duke of Edinburgh visited the transport museum, Mrs Hislop finished the bicycle exhibit. Its better when important events go smoothly.
Probe: transport or bicycle

33.
The concert was meant to be the high point of the season. Janet sat down in her leather chair before John started playing his white piano. They thought it was a very good performance.

The concert was meant to be the high point of the season. Before John started playing his white piano, Janet sat down in her leather chair. They thought it was a very good performance.
Probe: white or leather

34.
The political meeting was a bit of a shambles. The spokeswoman suggested her key idea before the man stepped onto the small stage. They all thought the meeting was a disaster.

The political meeting was a bit of a shambles. Before the man stepped onto the small stage, the spokeswoman suggested her key idea. They all thought the meeting was a disaster.
Probe: small or key

35.
It is very important to run a dinner party with decorum. Sophie got very drunk on gin before Stephen arrived with the party supplies. They both felt very embarrassed the next day.

It is very important to run a dinner party with decorum. Before Stephen arrived with the party supplies, Sophie got very drunk on gin. They both felt very embarrassed the next day.
Probe: party or drunk

36.
The trial was a test of the British justice system. The lawyer prepared his case carefully before Rose West was brought to court in handcuffs. They were widely reported in the media.

The trial was a test of the British justice system. Before Rose West was brought to court in handcuffs, the lawyer prepared his case carefully. They were widely reported in the media.
Probe: court or case

Experiment 8 – Proper Names (name vs. role) sentence continuation
1.
Mr Branson was dictating a letter. The secretary was taking shorthand.
The manager was dictating a letter. Jane was taking shorthand.

2.
Mr Larkin prepared for surgery. The nurse made the bed.
The surgeon prepared for surgery. Alice made the bed.

3.
George fixed the lights in the flower shop. The florist wasn't looking forward to getting the bill. The electrician fixed the lights in the flower shop. Flora wasn't looking forward to getting the bill.

4.
Susan recommended cutting out dairy products. The doctor agreed with the recommendation.
The dietician recommended cutting out dairy products. Mr Legg agreed with the recommendation.

5.
Tracy started sweeping the hair up. The barber put the scissors away.
The hairdresser started sweeping the hair up. Frank put the scissors away.

6.
Jean answered the door. The butler collected the coats.
The maid answered the door. Jeeves collected the coats.

7.
Chris put the boxing gloves away. The dancer put the tap shoes away.
The boxer put the boxing gloves away. Margot put the tap shoes away.

8.
Fred patrolled the offices after hours. The cleaner finished hoovering the first floor.
The guard patrolled the offices after hours. Mavis finished hoovering the first floor.

9.
Sally cleared the table. The waiter handed out the menu.
The waitress cleared the table. Manuel handed out the menu.

10.
Mr Johnson began speaking at the assembly. The teacher looked very bored by it all.
The headmaster began speaking at the assembly. Mrs Martin looked very bored by it all.

11.
David poured a large glass of wine. The nanny wasn't working tonight.
The bartender poured a large glass of wine. Susan wasn't working tonight.

12.
Naomi left the shop in a huff. The butcher had run out of sausages.
The model left the shop in a huff. Mr Jones had run out of sausages.

13.
Martin started drilling the rotten tooth. The Nutritionist recommended a change in diet.
The dentist started drilling the rotten tooth. Molly recommended a change in diet.

14.
Mandy really wanted to leave work early. The bank manager was in a really foul mood.
The bank teller really wanted to leave work early. Mr Jenkins was in a really foul mood.

15.
Josie hoped the naval ball was a success. Mr Collingwood wished the evening would never end.
The caterer hoped the naval ball was a success. Mr Collingwood wished the evening would never end.

16.
Kiera was sick of reading dusty law books. The lawyer prepared the final arguments.
The clerk was sick of reading dusty law books. Mr Foley prepared the final arguments.

17.
Bonnie waited for the music to come on. The client ordered a bottle of beer.
The exotic dancer waited for the music to come on. Gerry ordered a bottle of beer.

18.
Dennis got ready for a long day down the mine. The cashier counted last night's takings.
The miner got ready for a long day down the mine. Kelly counted last night's takings.

19.
Eleanor closed the library early today. The Mayor had called a town meeting.
The librarian closed the library early today. Mr Livingstone had called a town meeting.

20.
Jake prepared for the next trick. The magician's assistant got ready to be chopped in half.
The Magician prepared for the next trick. Rebecca got ready to be chopped in half.

21.
Charles finished writing the seminar speech. The typist started typing the speech up.
The Professor finished writing the seminar speech. Grace started typing the speech up.

22.
Emily began to pray. The priest started the service.
The nun began to pray. Father Stanley started the service.

23.
Miss Johnson was making the tea. The executive was on the phone.
The receptionist was making the tea. Mr Kellogg was on the phone.

24.
Amelia was rushed off her feet. The cook was in a very bad mood.
The waitress was rushed off her feet. Graham was in a very bad mood.

Experiment 9 - Proper Names (name vs. role) Self-paced reading
1.
Mr Branson was dictating a letter. The secretary was taking shorthand. It was getting to
be late in the afternoon.

The manager was dictating a letter. Jane was taking shorthand. It was getting to be late
in the afternoon.
Target sentence: She/He was beginning to feel hungry.

2.
Mr Larkin prepared for surgery. The nurse made the bed. The ward was very busy
today.

The surgeon prepared for surgery. Alice made the bed. The ward was very busy today.
Target sentence: She/ He has a lot to do today.

3.
George fixed the lights in the flower shop. The florist wasn't looking forward to getting
the bill. The electrics had fused yesterday.

The electrician fixed the lights in the flower shop. Flora wasn't looking forward to
getting the bill. The electrics had fused yesterday.
Target sentence: She/He was glad the lights were working again.

4.
Susan recommended cutting out dairy products. The doctor agreed with the
recommendation. Everyone should eat healthier these days.

The dietician recommended cutting out dairy products. Mr Legg agreed with the
recommendation. Everyone should eat healthier these days.

Target sentence: She/ He always tried to eat 5 portions of fruit and vegetables every day.

5.
Tracy started sweeping the hair up. The barber put the scissors away. The salon was shutting for the day.

The hairdresser started sweeping the hair up. Frank put the scissors away. The salon was shutting for the day.
Target sentence: He/ She had barely anytime to sit down all day.

6.
Jean answered the door. The butler collected the coats. The debutante ball was getting underway.

The maid answered the door. Jeeves collected the coats. The debutante ball was getting underway.
Target sentence: He/ She must ensure everything goes smoothly.

7.
Fred patrolled the offices after hours. The cleaner finished hoovering the first floor. It was very quiet at this time of night.

The guard patrolled the offices after hours. Mavis finished hoovering the first floor. It was very quiet at this time of night.
Target sentence: She/ He wanted to work more social hours.

8.
Sally cleared the table. The waiter handed out the menu. The lunchtime rush was almost over.

The waitress cleared the table. Manuel handed out the menu. The lunchtime rush was almost over.
Target sentence: He/ She prefers it when the café is busy.

9.
Mr Johnson began speaking at the assembly. The teacher looked very bored by it all. It was very cold this morning.

The headmaster began speaking at the assembly. Mrs Martin looked very bored by it all. It was very cold this morning.
Target sentence: She/ He wanted a cup of coffee.

10.
David poured a large glass of wine. The nanny wasn't working tonight. The bar was quiet this evening.

The bartender poured a large glass of wine. Sandy wasn't working tonight. The bar was quiet this evening.
Target sentence: She/He liked the atmosphere.

11.
Martin started drilling the rotten tooth. The Nutritionist recommended a change in diet. You really shouldn't eat too many sweets.

The dentist started drilling the rotten tooth. Molly recommended a change in diet. You really shouldn't eat too many sweets.
Target sentence: She/ He hoped the advice would stick this time.

12.
Mandy really wanted to leave work early. The bank manager was in a really foul mood. It had been really busy at lunchtime.

The bank teller really wanted to leave work early. Mr Jenkins was in a really foul mood. It had been really busy at lunchtime.
Target sentence: He/ She couldn't wait to get home.

13.
Josie hoped the naval ball was a success. The admiral wished the evening would never end. Quite a lot of people attended the ball.

The caterer hoped the naval ball was a success. Mr Collingwood wished the evening would never end. Quite a lot of people attended the ball.
Target sentence: He/ She was glad it went well.

14.
Kiera was sick of reading dusty law books. The lawyer prepared the final arguments. The case had been dragging on for months.

The clerk was sick of reading dusty law books. Mr Foley prepared the final arguments. The case had been dragging on for months.
Target sentence: He/She felt the case was finally prepared.

15.
Eleanor closed the library early today. The Mayor had called a town meeting. It was getting dark already.

The librarian closed the library early today. Mr Livingstone had called a town meeting. It was getting dark already.
Target sentence: He/ She was surprised about the huge turnout.

16.
Jake prepared for the next trick. The magician's assistant got ready to be chopped in half. The theatre was very full.

The Magician prepared for the next trick. Rebecca got ready to be chopped in half. The theatre was very full. She hoped the audience would be amazed.
Target sentence: She/ He hoped the audience would be amazed.

17.
Charles finished writing the seminar speech. The typist started typing the speech up. The seminar was next week.

The Professor finished writing the seminar speech. Grace started typing the speech up. The seminar was next week.
Target sentence: She/ He had a lot of things to do before then.

18.
Emily began to pray. The priest started the service. It was very peaceful in the church.

The nun began to pray. Father Stanley started the service. It was very peaceful in the church.
Target sentence: He/ She felt very relaxed there.

19.
Miss Johnson was making the tea. The executive was on the phone. The office was deserted.

The receptionist was making the tea. Mr Kellogg was on the phone. The office was deserted.
Target sentence: He/ She still had a lot of work to do.

20.
Mr Wood wished the court date were later. The assistant was sick of the late nights. There was always a last minute rush to get things done in time.

The solicitor wished the court date were later. Joan was sick of the late nights. There was always a last minute rush to get things done in time.
Target sentence: She/ He wanted an early night for a change.

21.
Amelia was rushed off her feet. The chef was in a very bad mood. The restaurant was short-staffed.

The waitress was rushed off her feet. Graham was in a very bad mood. The restaurant was short-staffed.
Target sentence: He/ She was due a break soon.

22.
Martin finished talking after an hour. The student had trouble paying attention. It was very warm in the lecture theatre.

The lecturer finished talking after an hour. Jessica had trouble paying attention. It was very warm in the lecture theatre.
Target sentence: She/ He felt quite tired.

23.
Mrs Allen didn't like to be kept waiting. The waiter was the only person serving. It was very busy in the restaurant.

The customer didn't like to be kept waiting. Jake was the only person serving. It was very busy in the restaurant.
Target sentence: He/. She just wanted to relax.

24.
Miss Jenkins loved working with small children. The school inspector wanted a day off. It was very noisy in school.

The nursery teacher loved working with small children. Mr Cliff wanted a day off. It was very noisy in school.
Target sentence: He/ She planned to go for drinks after work.

25.
Lennox put the boxing gloves away. The dancer put the tap shoes away. It was a very hot day.

The boxer put the boxing gloves away. Margot put the tap shoes away. It was a very hot day.
Target sentence: She/ He couldn't wait to jump in the shower.

26.
Debbie left the shop in a huff. The butcher had run out of sausages. It was very unusual for this to happen.

The beautician left the shop in a huff. Mr Jones had run out of sausages. It was very unusual for this to happen.
Target sentence: He/ She wasn't at all happy with the situation.

27.
Bonnie waited for the music to come on. The client ordered a bottle of beer. The music was turned up too loud.

The exotic dancer waited for the music to come on. Gerry ordered a bottle of beer. The music was turned up too loud.

Target sentence: He/ She was there till closing.

28.
Dennis got ready for a long day down the mine. The cashier counted last night's takings.
It was a very cold morning.

The miner got ready for a long day down the mine. Kelly counted last night's takings. It
was a very cold morning.
Target sentence: She/ He wanted to go back to bed.

29.
Patrick checked the surveillance cameras. The socialite had almost finished getting
ready. There was a schedule to stick too.

The bodyguard checked the surveillance cameras. Paris had almost finished getting
ready. There was a schedule to stick too.
Target sentence: She/ He felt tired already.

30.
Naomi was going to arrive late to the show. The Mechanic was trying to fix the car. The
clock was ticking.

The model was going to arrive late to the show. Terry was trying to fix the car. The
clock was ticking.
Target sentence: He/ She was not having a good day.

31.
Bruce kept checking people's tickets. The ballerina prepared for the opening scene. The
show was completely sold out.

The usher kept checking people's tickets. Katrina prepared for the opening scene. The
show was completely sold out.
Target sentence: She/ He loved the theatre.

32.
Colin liked female attention. The barmaid loved meeting celebrities. The venue was
extremely busy.

The actor liked female attention. Charlotte loved meeting celebrities. The venue was
extremely busy.
Target sentence: She/ He had a great time.

Experiment 10 – Proper Names (name vs. role) delayed probe recognition
1.
It was getting to be late in the afternoon. Currently, Mr Branson was dictating a letter
and the secretary was taking shorthand. They both were feeling a little bit hungry.

It was getting to be late in the afternoon. Currently, the manager was dictating a letter and Jane was taking shorthand. They both were feeling a little bit hungry.
Probe: Mr Branson or manager

2.
The ward was very busy today. The harried Mr Larkin prepared for surgery and the nurse made the bed. They had a lot of things to do today.

The ward was very busy today. The harried surgeon prepared for surgery and Alice made the bed. They had a lot of things to do today.
Probe: Mr Larkin or surgeon

3.
The electrics had fused yesterday. Quickly, George fixed the lights in the flower shop and the florist wasn't looking forward to the bill. They were very pleased with the results.

The electrics had fused yesterday. Quickly, the electrician fixed the lights in the flower shop and the flora wasn't looking forward to the bill. They were very pleased with the results.
Probe: George or electrician

4.
You should take better care of yourself these days. According to Susan cutting out dairy products was the way forward and the doctor agreed with the decision. You should always try to eat healthy food.

You should take better care of yourself these days. According to the dietician cutting out dairy products was the way forward and Dr Legg agreed with the decision. You should always try to eat healthy food.
Probe: Susan or dietician

5.
The salon was shutting for the day. Sulky Tracy started sweeping the hair up and the barber put the scissors away. They had barely anytime to sit down all day.

The salon was shutting for the day. The sulky hairdresser started sweeping the hair up and Frank put the scissors away. They had barely anytime to sit down all day.
Probe: Tracy or hairdresser

6.
The debutante ball was getting underway. Efficient Jean answered the door and the butler collected the coats. It's important to ensure everything goes smoothly.

The debutante ball was getting underway. The efficient maid answered the door and Jeeves collected the coats. It's important to ensure everything goes smoothly.
Probe: Jean or maid

7.
It was very quiet at this time of night. Quietly, Fred patrolled the offices after hours and the cleaner finished hoovering the first floor. They wanted to work more social hours.

It was very quiet at this time of night. Quietly, the guard patrolled the offices after hours and Mavis finished hoovering the first floor. They wanted to work more social hours.
Probe: Fred or guard

8.
The lunchtime rush was almost over.   Quickly, Sibyl cleared the table and the waiter handed out the menu. They prefer it when the café is busy.

The lunchtime rush was almost over.   Quickly, the waitress cleared the table and Manuel handed out the menu. They prefer it when the café is busy.
Probe: Sibyl or waitress

9.
It was very cold this morning. Slowly, Mr Johnson began speaking at the assembly and the teacher looked very bored by it all. A nice cup of coffee afterwards was much appreciated.

It was very cold this morning. Slowly, the headmaster began speaking at the assembly and Mrs Martin looked very bored by it all. A nice cup of coffee afterwards was much appreciated.
Probe: Mr Johnson or headmaster

10.
The bar was quiet this evening. Steadily, David poured a large glass of wine and the nanny was glad not to be working. They liked the atmosphere in the bar.

The bar was quiet this evening. Steadily, the barman poured a large glass of wine and Sandy was glad not to be working. They liked the atmosphere in the bar.
Probe: nanny or sandy

11.
You really shouldn't eat too many sweets. Professional Martin started drilling the rotten tooth and the Nutritionist recommended a change in diet. They hoped the advice would stick this time.

You really shouldn't eat too many sweets. The professional dentist started drilling the rotten tooth and Molly recommended a change in diet. They hoped the advice would stick this time.

Probe: nutritionist or Molly

12.
It had been really busy at lunchtime. Tired Mandy really wanted to leave work early since the bank manager was in a really foul mood. They couldn't wait to get home.

It had been really busy at lunchtime. Tired the bank teller really wanted to leave work early since Mr Jenkins was in a really foul mood. They couldn't wait to get home.
Probe: bank manager or Mr Jenkins

13.
Quite a lot of people attended the ball. Stressed Josie hoped it would be a success and the admiral wished the evening would never end. They were very happy that it went well.

Quite a lot of people attended the ball. The stressed caterer hoped it would be a success and Mr Collingwood wished the evening would never end. They were very happy that it went well.
Probe: Admiral or Mr Collingwood

14.
The case had been dragging on for months. Overworked Kiera was sick of reading dusty law books and the lawyer prepared the final arguments. They felt the case was finally prepared.

The case had been dragging on for months. The overworked clerk was sick of reading dusty law books and Mr Foley prepared the final arguments. They felt the case was finally prepared.
Probe: lawyer or Mr Foley

15.
It was getting dark already. Quickly, Eleanor closed the library early today and the Mayor started the town meeting. They were surprised about the huge turnout.

It was getting dark already. The librarian quickly closed the library early today and Mr Livingstone started the town meeting. They were surprised about the huge turnout.
Probe: mayor or Mr Livingstone

16.
The theatre was very full. Calmly, Jake prepared for the next trick and the magician's assistant got chopped in half. They hoped the audience would be amazed.

The theatre was very full. Calmly, the magician prepared for the next trick and Rebecca got chopped in half. They hoped the audience would be amazed.
Probe: magician or Rebecca

17.
The important conference was next week. Triumphantly, Charles had just finished writing the talk and the typist began typing the speech up. They still had a lot of things to do before then.

The important conference was next week. Triumphantly, the professor had just finished writing the talk and Grace began typing the speech up. They still had a lot of things to do before then.
Probe: typist or Grace

18.
It was very peaceful in the church. Serene Emily began to pray and the priest started the service. It was always a very relaxed and peaceful place.

It was very peaceful in the church. The serene nun began to pray and Father Stanley started the service. It was always a very relaxed and peaceful place.
Probe: priest or Stanley

19.
The office was deserted. Competent Miss Johnson was making the tea and the executive was on the phone. It was very early in the morning.

The office was deserted. The competent receptionist was making the tea and Mr Kellogg was on the phone. It was very early in the morning.
Probe: Miss Johnson or Mr Kellogg

20.
There was always a last minute panic. Worried Mr Wood wished the court date were later and the assistant was sick of the late nights. They both wanted to be completely prepared.

There was always a last minute panic. The worried solicitor wished the court date were later and Joan was sick of the late nights. They both wanted to be completely prepared.
Probe: Mr Wood or Joan

21.
The restaurant was short-staffed. Flustered Amelia was rushed off her feet and the chef was in a very bad mood. They were almost due a break soon.

The restaurant was short-staffed. The flustered waitress was rushed off her feet and Graham was in a very bad mood. They were almost due a break soon.
Probe: Amelia or Graham

22.
It was very warm in the lecture theatre. Finally, Martin finished talking after an hour and the student had trouble paying attention. If only the room had air conditioning.

It was very warm in the lecture theatre. Finally the lecturer finished talking after an hour and Jessica had trouble paying attention. If only the room had air conditioning.
Probe: Martin or Jessica

23.
It was very busy in the restaurant. The demanding Mrs Allen didn't like to be kept waiting and the waiter was the only person serving. The kitchen was currently running half an hour late.

It was very busy in the restaurant. The demanding customer didn't like to be kept waiting and Jason was the only person serving. The kitchen was currently running half an hour late.
Probe: Mrs Allen or Jason

24.
It was very noisy in school. Chirpy Miss Jenkins loved working with small children and the school inspector had a headache. The school can be very busy at times.
It was very noisy in school. The chirpy nursery teacher loved working with small children and Mr Cliff had a headache. The school can be very busy at times.
Probe: Miss Jenkins or Mr Cliff

25.
It was a very hot day. Sweaty Lennox put the boxing gloves down and the dancer put the tap shoes away. Time to jump into a nice warm shower.

It was a very hot day. The sweaty boxer put the boxing gloves down and Margot put the tap shoes away. Time to jump into a nice warm shower.
Probe: Lennox or Margot

26.
The shop was running low on supplies. Furious Debbie left the shop in a huff as the butcher had run out of sausages. Neither of them was happy with the situation.

The shop was running low on supplies. The beautician left the shop in a huff as Mr Jones had run out of sausages. Neither of them was happy with the situation.
Probe: Debbie or Mr Jones

27.
It was time to change the music over. Sensual Bonnie waited for the music to come on as the client ordered a bottle of beer. The club didn't close till quite late.

It was time to change the music over. The sensual exotic dancer waited for the music to come on as Gerry ordered a bottle of beer. The club didn't close till quite late.
Probe: Bonnie or Gerry

28.
It was a very cold morning. Hardworking Dennis got ready for a long day down the mine and the cashier counted last night's takings. They both wanted to go back to bed.

It was a very cold morning. The hardworking miner got ready for a long day down the mine and Kelly counted last night's takings. They both wanted to go back to bed.
Probe: cashier or miner

29.
There was a schedule to stick too. Massive Patrick checked the surveillance cameras and the socialite had almost finished getting ready. It was a very tight schedule.

There was a schedule to stick too. The massive minder checked the surveillance cameras and Paris had almost finished getting ready. It was a very tight schedule.
Probe: minder or socialite

30.
The clock was ticking. Glamorous Naomi was going to be late to the show and the mechanic was trying to fix the car. It was not turning out to be a good day.

The clock was ticking. The model was going to be late to the show and Terry was trying to fix the car. It was not turning out to be a good day.
Probe: mechanic or model

31.
The show was completely sold out. Patiently, Bruce kept checking people's tickets and Katrina prepared for the opening scene. The atmosphere in theatre was electric.

The show was completely sold out. Patiently, the usher kept checking people's tickets and the ballerina prepared for the opening scene. The atmosphere in theatre was electric.
Probe: usher or ballerina

32.
The venue was extremely busy. Vain Brad liked all the female attention and the barmaid loved meeting celebrities. They had a great time that night.

The venue was extremely busy. The vain actor liked all the female attention and Charlotte loved meeting celebrities. They had a great time that night.
Probe: barmaid or actor

33.
The office had a break-in over the weekend. Traumatized Sophie was glad not much was stolen and the janitor had to clean up the mess. Security needed to be made a priority from now on.

The office had a break-in over the weekend. The typist was glad that not much was stolen and Frank had to clean up the mess. Security needed to be made a priority from now on.
Probe: janitor or typist

34.
There had been a string of muggings in town. Desparate Sylvester needed to make some money fast and the victim was wearing an expensive watch. The crime rate in that area has been rising steadily.

There had been a string of muggings in town. The robber needed to make some money fast and Susanna was wearing an expensive watch. The crime rate in that area has been rising steadily.
Probe: robber or victim

35.
It's always a lot of hard work organizing a wedding. Blushing Joanne had everything planned and the groom was looking forward to dancing. They hoped the day would go perfectly.

It's always a lot of hard work organizing a wedding. The blushing bride had everything planned and Chris was looking forward to dancing. They hoped the day would go perfectly.
Probe: bride or groom

36.
Everyone loves hearing about Royal scandals. Disgraced Zara had been caught stealing and the bodyguard tried to cover it up. Some people just don't know how to behave.

Everyone loves hearing about Royal scandals. The disgraced princess had been caught stealing and Roger tried to cover it up. Some people just don't know how to behave.
Probe: princess or bodyguard

APPENDIX TWO

Table 1 the mean scores with scores of 0 to 3 indicates a strong bias towards a male in that role whereas a score of 3 and above indicates a bias towards a female in the role.

Role	Mean	Role	Mean
Nanny	6.2	Executive	2.2
Secretary	5.2	Waiter	0.6
Exotic Dancer	5.4	Butcher	1.8
Nurse	4.6	Manager	2
Florist	5.6	Surgeon	1.8
Dietician	4.6	Electrician	1
Hairdresser	4.8	Doctor	2.4
Maid	7	Barber	0.8
Cleaner	5.2	Butler	0
Waitress	7	Guard	1.8
Teacher	4.2	Headmaster	1.8
Nutritionist	3.8	Bartender	2.2
Bank teller	4.2	Dentist	2.2
Caterer	4.6	Admiral	0.6
Clerk	3.6	Lawyer	3
Librarian	5.4	Bank manager	1.4
Assistant	4.6	Mayor	1.6
Typist	5.6	Magician	1.4
Nun	6.8	Professor	2
Receptionist	5	Priest	0
Magician's assistant	5	Solicitor	2.6
Student	4	Chef	2.8
Customer	3.6	Lecturer	2.8
Nursery Teacher	5.2	School Inspector	2.8
Dancer	4.8	Boxer	0.4
Beautician	5.6	Client	2.2
Cashier	4.6	Miner	1.8
Socialite	4.8	Bodyguard	2.2
Model	4.4	Mechanic	1.4
Ballerina	5	Usher	2.6
Barmaid	6.4	Actor	1.4
Princess	6.7	Groom	0.4

APPENDIX THREE

To investigate the possibility digit span is related to the probe recognition scores, I correlated the performance on the span measure with the probe accuracy scores. These results produced only one significant trend in the younger age group in experiment four, which suggests younger adults with lower digits spans were less capable of recognizing a probe word contained within a baseline-type sentence. None of the correlations between probe accuracy and digit span were statistically reliable in experiments seven and ten. This would suggest that probe recognition scores are not mediated by working memory spans in both young and older adults.

Table 2 shows the correlations of digit span and probe recognition accuracy.

Experiment 4	Focus Probe Recognition	Baseline Probe Recognition	Anti-focus Probe Recognition	
Young Digit span	-.044	-.381*	.181	
Old Digit span	-.162	-.114	-.134	
Experiment 7	Main-sub-main Probe Recognition	Main-sub-sub Probe Recognition	Sub-main-main Probe Recognition	Sub-main-sub Probe Recognition
Young Digit span	.075	.208	-.200	.253
Old Digit span	-.234	.047	-.144	-.205
Experiment 10	Name-Role-Name Probe Recognition	Name-Role-Role Probe Recognition	Role-Name-Role Probe Recognition	Role-Name-Name Probe Recognition
Young Digit span	.168	.203	.016	.063
Old Digit span	-.284	-.042	-.132	-.024

*Correlation is significant at the 0.05 level