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Visual and Auditory Recognition Memory: An Examination of the Impact of Emotional Valence and Arousal Words on Aging and Remembering

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Abstract

Visual recognition memory research has shown conflicting findings when using the standard remember/know procedure (Gardiner, 1988; Tulving, 1985) to examine the impact of emotional valence and arousal items on adult aging and remembering. It has been suggested that the reason for the conflicting findings within visual recognition memory research is that the standard remember/know procedure inaccurately measures the remember and know responses that represent the dual-process theory of recognition memory (Jacoby et al., 1997). However, research from other perspectives such as the socioemotional selectivity theory (Carstensen et al., 2003) and the theory of response bias (e.g. Thapar & Rouder, 2009) has also produced conflicting findings when investigating the impact of visual emotions on adult aging and remembering, indicating that the conflicting findings within visual recognition memory research may not be due to the inaccuracy of the standard remember/know procedure. In addition, there is no evidence to suggest whether these conflicting findings extent to the study of auditory recognition memory also. Therefore, the present study uses the standard remember/know procedure, a modified remember/know procedure (Sheridan & Reingold, 2011), the response bias 'C' measure (Ingham, 1970), and visual and auditory self-relevance questionnaires created for the present study based on the notion of the socioemotional selectivity theory were used to investigate whether there is a significant differences between younger, middle-aged and older adults visual and auditory recognition memory performance for positive, negative and neutral valence (neutral arousal) words. Based on the results of the remember/know, response

bias and self-relevance data, the visual and auditory standard and modified remember/know procedures produced conflicting findings between the three adult age groups and the response bias measure revealed that response bias did not significantly affect remember and know responses. Interestingly, there was no significant difference between visual and auditory recognition memory performance and there were significant self-relevance scores between the three adult age groups. Essentially, researchers need to urgently reconsider the type of remember/know procedure that they use to in future studies to research the impact of emotions on adult aging and remembering.

Key terms: Visual Recognition Memory, Auditory Recognition Memory, The Remember/Know Procedure, Adult Aging, Remembering, Response Bias, Socioemotional Selectivity Theory.

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1. Literature Review

1.1. Introduction

Human memory cannot be considered a single functioning or unitary process. In fact, humans have demonstrated that they have several internal processes such as procedural, semantic and episodic memory, which are reconciled by different brain regions and to some extent are independent of one another. Within an everyday environment, these different memory systems can operate similarly, interact effortlessly, and when damaged can provide unity in compensating overall cognitive performance (Eysenke & Keane, 2007). However, despite being able to observe these important functions of human memory, the way memory permits an individual to recollect their past so that they may adapt to their future, remains arguably one of the most complex cognitive abilities within human cognition. Even with over two thousand years worth of theoretical and experimental contributions from philosophical, psychological and neurological related disciplines, there is still no universal concept for explaining the selection, retrieval, encoding and storage mechanisms that are associated with recollection (Ghetti & Bauber, 2012). As a consequence, empirical research into the study of recognition memory has continued to extensively investigate this phenomenon known as recollection.

1.2. The Study of Recognition Memory

Recognition memory is a component of declarative memory (i.e. the long-term memory system responsible for the recall of facts and knowledge) and is the name often given to the study of recollection. To investigate recollection, there are two predominant ideologies with recognition memory research, which share the desire to attain a definitive comprehension of recollection. However, they pursue this understanding of recollection with incompatible beliefs. These opposing viewpoints are referred to as *dual and single process theories of recognition memory*.

1.2.1. Dual Process Theory and the Remember/Know Procedure

The first concept to be discussed, the dual-process theory, proposes that there are two ways in which an individual can recall their past. An individual can either *recollect* contextual details about an environment due to the identification of specific information relating to a particular item (i.e. a person's name) or an individual could perceive an item to be familiar, implying that the individual is only able to recognise non-contextual details about the items (i.e. an awareness that the item have been experienced before, but not being able to establish where from). These mechanisms are called *recollection* and *familiarity,* respectively (e.g. Atkinson & Juola, 1973, 1974; Hintzman & Curran, 1994; Jacoby, 1991; Jacoby & Dallas, 1981; Mandler, 1980; Mandler, 2008).

The following anecdote exhibits an everyday situation, whereby recollection and familiarity are utilized;

'You see a man on a bus whom you are sure that you have seen before; you 'know' him in that sense. Following this recognition you begin a search process asking yourself questions such as 'Where could I know him from? Who is he?' This search process then generates likely contexts (i.e. Do I know him from work; is he the postman; is he off the television). Eventually the search may end with the insight, That's the butcher from the supermarket!'

(Mandler, 1980, pg. 254)

As illustrated by the example above, recognising the man on the bus as being familiar is not significant enough to recollect the man's identity. Recollection in this instance is only achievable when the search process subsequent to familiarity (i.e. Who is that man?) is able to associate the current encounter with the man on the bus with stored contextual information relating to their previous encounter (e.g. Have I met him in the supermarket?). If an association is achieved between the past and the present encounters, then the man should be remembered as the butcher from the supermarket. Accepting this interpretation as being applicable for explaining the occurrence of recollection in a human's everyday interactions, some dual-process theorists have argued that recollection should be considered as a process that functions solely on association (e.g. Holdstock et al., 2002; 2005).

However, other dual-process researchers have argued that the retrieval of associative information alone may not elicit a state recollection, in this case for the man on the bus, if the present cues do not resemble the information retrieved on the man when he was encountered in the supermarket (e.g. Khoe et al., 2000). For instance, if the individual only notices a distinctive scent of meat on the man, then when the individual next encounters the man, the same distinct scent of meat would have to be present in order for recollection to occur. Therefore, it is perceived as a misconception to think that the individual recalls the man on the bus due to the many possible vivid and intricate associations that could be established, when these would have been irrelevant if they did not replicate an individual's personal memory of the previous encounter with the man at the supermarket (i.e. I remember the butcher because he distinctively smelt of meat) (e.g. Khoe et al., 2000).

Acknowledging that associative information operates recollection based on an individual's selection of details from a previous environment, some dual-process researchers aspired to explain when the association is most vital in the processing of recollection experiences. For example, Jacoby (1991) argued that associative information is optimal after recollection has been obtained, due to an innate requirement of humans to control a situation using the contextual details they have retrieved from recollection. Jacoby (1991) suggested that remembering the contextual details of an item is not always beneficial and being able to use the accessible associative information to acknowledge this preserves a human's ability to consciously employ or withhold knowledge. So with regards to Mandler's (1980) example, if the butcher on the bus was

remembered as being particularly bad mannered, then associative information will develop remembering the situation to the extent that an individual would avoid future contact with the butcher. In effect, associative information could enhance remembering so that an individual learns to predict the possible outcome of engaging items within a recognizable situation.

Other researchers such as Tulving (1985) have proposed that it is a certain level of self awareness labelled as *autonoetic awareness* that is needed to obtain the associative information required to achieve recollection. Tulving (1985) suggested that without autonoetic awareness, an individual will not be attentive to any details within an encounter, because the individual will be unable to comprehend how any details in a present environment will be useful to represent their self identity in a future encounter. In effect, autonoetic awareness directs the sufficient level of attention needed for compelling an individual to consciously associate items in an environment with their self identity (Tulving, 1989). Nevertheless, it was the former assumption of *self awareness* proposed by Tulving (1985) that has remained popular amongst dual-process theorists. Primarily, this is because Tulving (1985) also assigned levels of required self awareness to familiarity and implicit experiences that occur with no conscious identification of any details experienced before. Essentially, this distinguished recollection as its own recognition memory process (Conway, 2005).

Developing on from earlier evidence (Tulving, 1972; Tulving, 1983; Tulving et al., 1982), Tulving (1985) theorized that recognition memory is operated by three memory systems; procedural, semantic and episodic, with each memory

system activating its own different state of awareness. The lowest level, *anoetic awareness,* is an unconscious process that activates procedural memory and ensures that an individual 'knows' when an item is significant without any further understanding. Although Tulving (1985) identified procedural memory within recognition memory, he advised that very simple organisms have this memory system, granting a 'item only response' learning to an individual (i.e. an ability to perform a certain behaviour, when a certain item is present) that is slightly more sophisticated than basic instinct, but does not contribute to the conscious necessity of recognition memory. The next level, *noetic awareness,* is the type of conscious awareness that activates semantic memory and familiarity. Tulving (1985) referred to familiarity as 'know', as an individual knows a presented item exists based on their internal and external knowledge of the world. Finally the highest level, *autonoetic awareness,* is the type of conscious awareness that activates episodic memory and recollection. Tulving (1985) referred to recollection as 'remember', due to an individual remembering autobiographical details (i.e. times, events, associated emotions) about an item in relation to their self identity. This prominent hypothesis within dual-process theory is referred to as the *remember/know procedure* (e.g. Gardiner, 1988; Tulving, 1985; Yonelinas, 2001; Wheeler & Buckner, 2004).

1.2.2. Single Process Theory and the Signal Detection Procedure

In contrast to dual-process theories of recognition memory, single-process theories claim that recognition memory decisions are based on a continuum of weak to strong familiarity. For instance, using the Mandler (1980) example, recognising the man on the bus would be a weak familiarity decision, whilst

recognising the man as the butcher from the supermarket would be a strong familiarity decision. In effect, single-process theories assume that recollection does not play a significant function in recognition memory, if any role at all (Yonelinas, 1994; Yonelinas, 2001). Nevertheless, the familiarity attribute of dual and single process theories are not parallel. This is because single-process theories depict familiarity as the underlying factor for the unidimensional memory strengths of recognition memory decisions (ranging from low to high), which also denotes that the semantic memory system has a sole influence recognition memory. Consequently, single-process theories unconditionally contradict dual-process theories, contesting the neural processing of recognition memory (i.e. no involvement of episodic memory) and evidently a human's capacity to truly remember their past (Yonelinas, 2002).

Since *single-process* theory is compatible with the *signal detection model,* recognition memory decisions have been tested using a memory signal strength based on a decision criterion (e.g. Donaldson, 1996; Dougal & Rotello, 2007; Dunn, 2004, 2008; Healthcote et al., 2010; Hicks & Marsh, 1999; Hirshman & Henzler, 1998; Hirshman & Master, 1997; Inoue & Bellezza, 1998; Malmberg et al., 2004; Slotnick & Dodson, 2005; Wais et al., 2008 ;Wixted & Stretch, 2004). The typical version of *signal-detection* theory used is the *equal-variance detection model.* This model provides two equal-variance Gaussian distributions (representing correct and incorrect recognition memory decisions) and one decision criterion. If any test items produce sufficient memory strengths to exceed the decision criterion, then it is stated as being *old* and if it does not, then it is perceived as *new* (Wixted, 2007). The *signal detection* approach

therefore deems recognition memory to be measureable through a purely quantitative approach, which measures the strength of memory, as opposed to the more qualitative approach of *dual-process theory* that focuses on the measuring the content of memory (Wixted and Mickes, 2010).

1.2.3. The Emergence of the Dual Process Remember/Know Procedure

Amid the recognition memory literature, there are research findings that have been readily accepted as supporting evidence for both models (e.g. see Wixted, 2007 for a review). However, in order to capture the vividness of memory, the idea of testing only memory strength (*signal-detection)* would seem insufficient. Anderson and Bower (1972) summarised that 'undifferentiated strength of familiarity concept is not sufficiently rich to account for the subject's ability to differentiate sets of items' (Anderson & Bower, 1972, p.100). In addition, Gardiner and Richardson-Klavehn (2000) later agreed that 'one cannot tell what subjects experience mentally from purely objective measures of their performance. If one wants to be able to take into account the subjective awareness of memory, there is no alternative to the use of subjective reports' (Gardiner & Richardson-Klavehn, 2000, pg.230) These views are generally shared by the majority of recognition memory researchers and has produced a popularity for the dual-process theory and most noticeably from the theoretical perspective of the *remember/know procedure* (Gardiner., 1988; Tulving, 1985), which in 2009 alone was used in over 30 publications (Wixted & Mickes, 2010).

The *remember/know procedure* became innovative because it categorised recollection and familiarity into two states of conscious awareness known as remember (recollection) and know (familiarity), and matched them to two memory processes. Remember, was associated with the retrieval of episodic memories, essential for the awareness of autobiographical meaning of past events. Know, was associated with the retrieval of semantic memories and involved the awareness of previously attained knowledge, without the need for any autobiographical mechanisms (Tulving, 1985). By considering recognition memory in this way, Tulving (1985) proposed that researchers would be able to understand the memory processes being used by participants during a recognition memory task, by having the participants' indicating their state of awareness using remember (episodic) or know (semantic) responses. It was Gardiner (1988) that eventually implemented the parallel between remember/know and recollection/familiarity into an experimental framework.

The basic experimental procedure of the remember/know procedure tends to involve study and test phases. The study phase allows for participants to be presented different items, whilst the test phase permits remember/know responses to be recorded. For instance, following the study phase, participants' would be asked to state a 'know' response if they recognise an item without any specific detail, and to state a 'remember' response if they could recall various contextual detail about the items (i.e. an association between the items and a personal memory). With this framework, dual-process researchers have been able to manipulate different items in conjunction with human sensory modalities. For example, visual recognition memory research has studied the effects of

visually presented; words, sentences, pictures, faces and events, in order to understand which types of visual items produce increased remember responses (e.g. Kensinger and Schacter, 2007; Richardson et al, 2004; Rotello and Curran, 2007; Rugg and Curran, 2007). In the main, results from visual recognition memory research indicate that remember responses are enhanced by the inclusion of emotionally evocative items (i.e. positive and negative items) and know responses are enhanced by the inclusion of perceptual items (i.e. varying the size of an item) (Schmid and Mast, 2010).

The findings for emotions increasing remember responses were in some respects expected. In fact, it had already been documented that emotions have an effect upon the remembering of possible life events such as eyewitness memory (e.g. Chrisianson & Loftus, 1987; Park, 2005), flashbulb memories (e.g. Brown & Kulik, 1977; Conway et al., 1994, Labar & Cabeza, 2006; McGaugh, 2004) and traumatic memories (e.g. Depue, et al., 2007; Marx, et al., 2008). Nevertheless, it was also acknowledged that some of these investigations into emotion and memory did not always conclude that emotion enhances memory (reviewed by Holland & Kensinger, 2011; Levine & Edelstein, 2009; Mather & Sutherland, 2011; Reisberg & Heuer, 2004), with some research even suggesting that emotions can have an adverse effect on the remembering within certain circumstances (see Kihlstrom, 2006; Heuer & Reisberg, 2007 for reviews of emotions adversely effecting memory for crime scenes that have involved weapons). Accordingly, recognition memory research began to examine whether the two characteristics of emotion valence and arousal have any impact on recollection/remember responses.

1.3. Evidence on the Effects of Valence and Arousal on Remember/Know Performance

Emotions are often considered to vary across the dimensions of valence (how positive or negative an item is) and arousal (how exciting or calming an item is) (Russell, 1980; Bradley & Lang, 2000). An individual's experience of emotional information can exist anywhere between these dimensions, be it low in arousal and positive valence (feelings of calmness), low in arousal and negative valence (feelings of depression), high in arousal and positive valence (feelings of excitement), or high in arousal and negative valence (feelings of agitation). There are relatively few studies that have explored the effects these dimensions have on remember responses using the remember/know procedure. Nonetheless, the available evidence has revealed that valence and arousal can impact remember and know responses differently (e.g. reviewed by Dolan, 2002; Wolf, 2008).

In terms of arousal, a vast majority of studies have focused on how items that elicit high emotional arousal are perceived as being important for improving remembering. Using high arousing items appear to indicate that remember responses are increased due to interactions between the hippocampus and the amygdala brain regions (e.g. Cahill & McGaugh, 1998; Dolcos & Denkova, 2008; Dolcos, et al., 2004; Hamann & Mao, 2002; Kensinger & Corkin, 2004; McGaugh, 2004). For instance, Kensinger & Corkin (2004) used the remember/know procedure to instruct participants to observe words that were of high or low arousal. The items in the study phase were observed with either full attention (i.e. the participants focused just on the items from the recognition

memory task) or divided attention (i.e. the participants observed items from the recognition memory task and a sound discrimination task), whilst the items throughout the test phase was observed with full attention. The participants remember/know responses and associated brain activity was recorded for the high and low arousing items. The results of the study demonstrated that for the high arousing items, there was a significant increase in remember responses and a strong correlation between the activity of the hippocampus and the amygdala. Whereas, for the low arousing items there was a significant increase in know responses and a strong correlation between the hippocampus and the prefrontal cortex. In addition, the inclusion of a divided attention condition did not affect the total number of high arousing items that were remembered, but it did affect the total number of low arousing items that were remembered. Thus, high emotional arousing items could be identified as the critical factor for initiating an interaction between the hippocampus and amygdala, which is essential recruiting the attention needed for the selection of items in an environment and for increasing the retrieval of remember responses (e.g. Cahill & McGaugh, 1998; Dolcos & Denkova, 2008; Dolcos, et al., 2004; Hamann & Mao, 2002; Kensinger & Corkin, 2004; McGaugh, 2004).

Nevertheless, research that has measured items that evoke positive or negative valence with no changes in high or low arousal have also been shown to increase remember responses (e.g. Kensinger & Corkin, 2003; Oschner, 2000). Certainly, these studies did acknowledge that items that are high arousing can elicit the attention required to process remember responses. However, it was argued that the level of attention necessary for processing an item will be

automatically attained if the positive or negative valence component of the item modulates the vividness of a memory to the point it is remembered (Kensinger, 2009). For instance, if an individual was presented a negative valence word with high arousal such as *terrorist* (Bradley & Lang, 1999), the individual will not focus attention on the word because it is high arousing, but because the negative valence implications of the word relate to a negative experience the individual has had in their past. In effect, valence is believed to be the component of emotional items that achieves a state of remembering within recognition memory.

To assess the influence valence had on remembering, researchers compared positive low and high arousing emotional items with negative low and high arousing emotional items. Theoretically, if there were inconsistencies between the positive and negative high arousing items, then arousal could not be the feature of an emotional item that increases remember responses. Several laboratory studies have indicated that valence increases and elicits the subjective vividness of remember responses (Bless & Schwarz, 1999; Dewhurst & Parry, 2000; Goldinger & Hansen, 2005; Kensinger & Corkin, 2003; Mickley & Kensinger, 2008; Oschner, 2000; Sharot et al., 2007; Talmi et al., 2007). For instance, negative high arousing items generate an increase in remember responses with a greater sense of vividness than positive high arousing items (e.g. Dewhurst & Parry, 2000; Oschner, 2000). In contrast, positive high arousing items are more likely to generate an increase in know responses with nonspecific information (Bless & Schwarz, 1999; Oschner, 2000). A similar pattern of results has been found when measuring individuals with different

demographics such as age, with younger adults remembering more negative high arousing items and older adults remembering more positive high arousing items (e.g. Kensinger et al., 2007). Subsequently, the quantity and subjective vividness of remembering is dependent upon the positive or negative valence of an emotional item and the individual differences between humans.

1.4. Conflicting Evidence for Aging upon Emotional Recognition Memory

However, there is conflicting evidence with regards to the way in which valence and arousal affects the ability to remember as humans age, particularly when an individual reaches the stage of adulthood (the age of 18 and upwards). It has often been anticipated that with healthy aging comes various types of cognitive decline, including a reduction in the quality and strength of emotional memories (e.g. Salthouse, 2004; Shapiro & Penrod, 1986). Some researchers such as Crook and Larrabee (1992) went as far as identifying the age of cognitive decline for memory, with individuals showing significant decrements by age 50, and individuals aged 70 and over displaying the most severe memory impairment (i.e. these individuals demonstrated elevated levels of incorrect responses and a decrease in correct responses). Nevertheless, there are numerous studies that have revealed that the processing of emotional memories is maintained across adult age groups (Kensinger et al., 2002; Mather & Sutherland, 2009; May et al., 2005) and even though older adults show a decline in memory in comparison to younger adults, both younger and older adults remember emotional information more than neutral information (Davidson & Glisky, 2002; Denburg et al., 2003; Kensinger et al., 2002; Old &

Naveh-Benjamin, 2008; Otani et al, 2007). Thus, age-related deficits in remembering could perhaps be counteracted by the emotionality of an item.

Previous research has generally found that younger adults remember negative valence items better than positive valence items (e.g. Dewhurst & Parry, 2000; Mather et al., 2000; Oschner, 2000) and older adults remember positive valence items better than negative valence items (Mather & Carsentensen, 2005). It has been suggested that this pattern of results could be due to older adults being able to identify and to elaborate on positive items with personal significance to their own lives, whereas younger adults remember negative items more as they attribute to the perceived perception they have of their own lives (Wood & Kisley, 2006; Kensinger & Leclerc, 2009; Mather & Sutherland, 2009). These effects are referred to as the positivity and negativity effect, respectively. Nevertheless, these effects are not always observable, with some studies finding that younger adults remember positive items better than negative items (Kensinger, 2008; 2009; Murphy & Isaacowitz, 2008; Waring & Kensinger., 2009). Kensinger (2008) even found that older adults will have an increased remembering for positive valence items with neutral arousal and younger adults will have an increased remembering for negative valence items with neutral arousal (i.e. emotional items that are neither calming nor exciting), as opposed to positive or negative valence items that have high or low arousal. This indicated that both valence and arousal should be considered concurrently when examining age and remembering. Evidently, there appears to be support for an association between aging and remembering emotional items, however,

there is not enough evidence to suggest whether it is positive or negative items that are remembered most effectively amongst younger and older adults.

1.5. Does the Remember/ Procedure Accurately Measure Remember and Know Responses?

When there are inconsistent results, in this case between the levels of positive and negative emotional items being remembered by younger and older adults, a researcher has to examine whether a prevalent pattern of results could be caused by the methodology used. After an examination of the previous recognition memory research, it was apparent that concurrently developing a study that investigates remember responses between younger and older adults for positive and negative emotional items using the remember/know procedure could have potential issues. Primarily, these issues are concerned with how the remember/know procedures function remember and know responses.

There is controversy surrounding whether or not the remember/know procedure's know response measure can be assumed to be an accurate representation of familiarity (e.g. Geraci et al., 2009; Hirschman & Henzler, 1998; Jacoby et al., 1997). In particular, Jacoby et al (1997) argued that the know response measure inadvertently underestimates the contribution of familiarity to recognition memory performance, because the remember/know procedure is methodologically biased towards measuring remember responses. For instance, the qualitative feedback obtained from a remember response is the component of recognition memory that is believed to reflect an individual's unique selection and retrieval of items in an environment (Tulving, 1985).

Jacoby et al (1997) advocated that there is actually a possibility that some items an individual is presented can be both recollected and familiar. For example, an individual could initially find an item familiar, but then after a few seconds recollect specific details about the item. However, the remember/know procedure forces an individual to choose either remember or know responses for an item, not both at the same time. Whenever recollection occurs, regardless of the presence of familiarity, an individual is instructed to record a remember response. Consequently, if an item is both recollected and familiar, then the inability to select a know response in addition to a remember response will contribute to the underestimation of familiarity performance.

This underestimation of familiarity responses is considered to have inferences on dissociations (i.e. discrepancies) in research that has implemented the remember/know procedure. For Instance, Parkin and Walter (1992) reported a dissociation that showed younger adults to have higher levels of remembering than older adults, but older adults to have higher levels of knowing than younger adults. Jacoby (1997) argued that this dissociation is an unlikely function of aging, commenting that ‘although it may be comforting to think that deficits in recollection are offset by improvements in familiarity, this pattern of results appears to be an artifact of the remember/know procedure’ (Jacoby et al., 1997, pg. 35). The more likely explanation of dissociations such as that found in Parkin and Walter (1992) is that items with high levels of remembering could constrain the number of items that can be recorded as know responses, creating artificial dissociations which make experimental manipulations that could make significant influences on remembering appear insignificant or

reverse the effects to the extent that know responses exceed remember responses. Effectively, the higher levels of remember responses for younger adults underestimates their levels of know in comparison to older adults (Jacoby et al., 1997).

Conversely, researchers such as Gardiner (1996) questioned the relationship between an increase in remembering and an underestimation of know responses. In fact, Gardiner (1996) conducted three experiments that had different experimental manipulations, which all demonstrated a pattern of increased remembering, but no effect on knowing. In conclusion, Gardiner (1996) argued that this type of dissociation is ‘at variance with the idea that as a general rule, response exclusivity produces opposite effects on know responses when there are large effects on remember responses’ (Gardiner., 1996, pg. 119). In effect, know responses are not always underestimated, which has been shown even when there are different experimental manipulations. Nonetheless, research such as Hirschman and Master (1997) reviewed the remember/know literature and suggested that there were seven experimental variables that consistently increase remember responses, yet inconsistently affect know responses.

An attempt has been made to use a calculation which is believed to compensate the underestimation of know responses without the necessity for altering the remember/know procedure. This calculation known as the *Independence formula* was proposed by Yonelinas and Jacoby (1995) and is expressed as follows;

$$F = K/[1 - remember]$$

Given this equation, it was assumed that to avoid calculating both remember and know responses solely as remember responses when using the remember/know procedure, researchers need ‘to determine the probability that an item is familiar (F), divide the proportion of know responses (K) by the opportunity the subject has to make a know response (1 – remember)’ (Yonelinas & Jacoby, 1995, pg. 9). In effect, this calculation acknowledges the occurrence of remember and know responses, but tries to distribute them amongst the remember and know processes that form recognition memory decisions. Numerous studies have used this independence formula as an unbiased method for measuring remember and know responses (see Wixted, 2009 and Yonelinas, 2002 for reviews on the literature that has used the Yonelinas and Jacoby’s independence formula, 1995). However, it has been argued by some remember/know researchers that using the independence formula is still biasing the know responses, because know responses are ‘not free to independently vary between chance and perfect performance’ (Sheridan and Reingold, 2011, pg. 1366). Effectively, it is considered unrealistic to incorporate a calculation to predict know responses, due to the reality being that an individual’s recognition behaviour is exclusive to them. Thus, to obtain a bias free know response measure, only a remember/know procedure that permits the concurrent measurement of remember and knowing will suffice (i.e. the current remember/know procedure) (e.g. Naveh-Benjamin & Kilb, 2012; Ozubko et al., 2012; Sheridan & Reingold, 2011). Conclusively, it remains a debatable

issue as to whether or not studies that use the remember/know procedure are continuing to underestimate know responses.

1.6. The Application of the Socioemotional Selectivity Theory to the Aging and Emotional Recognition Memory Debate

From a social cognitive perspective, researchers have argued that examining the characteristics of valence and arousal will not fully explain aging and remembering, because memory is an 'elaborative process in which current goals influence constructions of the past' (Charles et al., 2003). This means that the events, people and locations that an individual retrieves from their memory are determined by their current state of well-being (e.g. mood state). According to the socioemotional selectivity theory (Carstensen, 1993, 1995, 2005; Carstensen et al., 2003; Carstensen et al., 1999), an individual's well-being is motivated by a conscious and unconscious awareness of the time they feel they have left in life, and it is this perception of a limited amount of time which directs older individual's to focus on remembering emotional items. On the contrary, healthy younger adults are assumed to have an expansive amount of time which motivates them to acquire new information regardless of the emotionality of the item. This notion of the socioemotional selectivity theory is supported by empirical evidence, such as Carstensen and Fredrickson (1998) which showed that younger adults approaching the end of life demonstrate a comparable quantity of emotional remembering as older adults, and older adults have a disproportionately better memory for emotional items than neutral items (Carstensen & Turk- Charles, 1994). Therefore, as individual's age, they continue to invest their cognitive resources into remembering meaningful

emotional items for the reason that they are motivated to engage emotional items that consolidate their past memories (Penningroth & Scott, 2012).

Research that has implemented the socioemotional selectivity theory has posited that as an individual continues to age, they will remember positive emotional items better than negative items due to an improvement in emotion regulation. Emotion regulation is defined as the ability to extract positive information and disregard negative information from an environment (Carstensen et al., 2000; Charles et al., 2001). This assumption is parallel to the findings that have found that the valence of an item has a positivity effect on older adults (Wood & Kisley, 2006; Kensinger & Leclerc, 2009; Mather & Sutherland, 2009) in the sense that they both suggest that older adults remember positive items better than negative items. However, in consideration of the socioemotional selectivity theory, the differences between remembered positive and negative items for older adults indicates a self capacity to remember items that is not driven by discrepancies in younger and older individual's memory (e.g. Charles et al., 2003). For instance, older adults are not allocated with the disproportionate selection of positive items because of cognitive decline, but because they have a conscious and unconscious choice to select the positive items. Hence, if the selection of emotional items in aging was based on cognitive decline, then older adults should equally remember both positive and negative items.

The findings that have examined the emotion regulation of aging have used a range of self-report measures such as questionnaires and surveys to reveal that individuals as a minimum sustain positive remembering over time (e.g. Charles

et al., 2001; Lang & Carstensen, 2002) and in one incidence they were shown to have an increasing amount of positive remembering as they aged (Mroczek & Kolarz, 1998). Possible explanations for these findings could be that older adults have shorter periods of negative mood throughout the day (Carstensen et al., 2000) and they report a greater contentment towards the remembering of positive items than negative items relative to younger adults (Lawton et al., 1993). Then again, there are instances when older adults produce a noticeable decrease in remembering of emotions, in particular positive emotions that resemble excitement, because they do not possess the same ability as younger adults to externally process (i.e. the successful containment of an individual's feelings to others) and internally process (i.e. being able to dynamically enhance mood at will) emotional information (Lawton et al., 1992; Gross et al., 1997). Evidently, the socioemotional selectivity theory has been unable to offer a definite understanding as to whether or not individuals acquire an enhanced emotional regulation for positive items as they age.

1.7. Is Emotional Recognition Caused by Response Bias?

In view of the findings into the effects emotional items have on adult aging and recognition memory, it would seemingly appear that the presentation of emotional items throughout an adult's lifecycle signifies a superior ability to remember the past. However, this presumption may not necessarily be warranted, as another alternative notion to the aforementioned conclusion could be that the pattern is merely an indication of the response biases that adults of various ages express towards emotional items (Bastin & Van der Linden, 2003; Deason et al., 2012; Dougal & Rotello, 2007; Ferris et al., 1980; Flicker et al.,

1990; Grider & Malmberg, 2008; Kapucu et al., 2008; Thapar & Rouder, 2009; Vakil et al., 2003; Windmann & Kutas, 2001). Response bias is a type of cognitive bias whereby an individual selects a response in the way they think a researcher wants them to answer, rather than to their own beliefs. This could have an impact on the results of aging and recognition memory research for emotional valence items, as younger and older adults may favour positive and negative items to neutral items differently as opposed to cognitive decline impacting the remembering of positive and negative items differently. The notion of response bias influencing aging does resemble the socioemotional selectivity theory in the sense that both postulate that the individual self-regulates the choice to select emotional items. However, the notion of response bias suggests that self-regulation arises from several possible mechanisms, such as the tendency for individuals to guess that they have studied an emotional item over a neutral item when they are unsure (Thapar & Rouder, 2009).

Response bias quantifies an individual's tendency to respond to an item in two directions. An individual can respond in either a predominately liberal direction which suggests that they are more inclined to record a 'yes' response (i.e. an individual will be more likely to state that an item was in the study phase), or a predominately conservative direction which suggests that they are more inclined to record a 'no' response (i.e. an individual will be more likely to state that an item was new and not present in the study phase) (Huh et al., 2006). Using these previously noted measurements of response bias, several studies

investigating recognition memory and aging have indicated that emotional valence items are biased differently by younger and older adults.

However, the reported differences between younger and older adults response bias has been mixed. For instance, Thapour and Rouder (2009) found that younger adults display a more liberal response bias for negative words, whereas older adults displayed a more liberal response bias for positive words. Yet, Ferris et al (1980) and Vakil et al (2003) that older adults demonstrate a more conservative bias regardless of the item valence type (i.e. positive, negative or neutral). Then again, Bastin and Van der Linden (2003) and Flicker et al (1990) suggested that older adults actually have a more liberal response bias independent of the item valence type. The other studies have generally revealed that younger adults have a more liberal bias towards negative items, whereas older adults have neither a conservative or liberal bias towards positive and negative items (Deason et al., 2012; Dougal & Rotello, 2007; Grider & Malmberg, 2008; Kapucu et al., 2008; Windmann & Kutas, 2001). Even though these findings are in disagreement, the facility of remembering emotional items for younger and older adults could be construed as an outcome of response bias as opposed to being an exclusive human memory function.

1.8. Comparing Sensory Modalities: Assessing Auditory In addition to Visual results

The preceding sections within this literature review have illustrated studies that concentrate on visually presenting emotional items to participants. To note, there is not a preconception to develop a study that measures visual recognition

memory using the remember/know procedure. Simply, there are insufficient studies that have measured the influence of emotional items on the recognition memory with regards to other human sensory modalities (there are four excluding visual; auditory-hearing, somatosensory-touch, gustatory-taste, olfactory-smell). Even excluding the studies that have implemented the remember/know procedure to researching the other sensory modalities, recognition memory research has continued to opt for researching visual recognition memory. Granted, due to there being many contradictory findings in the visual domain as detailed in the previous sections, enduring visual recognition memory research until clear answers are acquired could be the logical course of action (as argued in e.g. Bridgeman et al., 1979; Russell, 1980; Hollingworth, 2006; Raymond, 2009). Interestingly however, when examining the available evidence into auditory recognition memory, although visual and auditory recognition memory operate and process differently (i.e. are utilised by distinctive brain regions, which receive information relating to items in an environment differently), both domains similarly equip an individual to remember specific details of their past (Chartrand et al., 2008; Cohen et al., 2009; Cohen et al., 2011; Cycowicz & Friedman, 1999; Drakeford et al., 2006; Gottlieb et al., 2010; Nadine, 2010).

On the basis of human evolution, an individual has evolved with a multitude of sensory modalities. For all memory processes, these sensory modalities are vital for the intake of information concerning an item (i.e. an item has information that be can be seen, heard, touched, tasted and smelt by an individual) (Kung, 2005). Once this information is received, the memory

processes such as recognition memory actively use the information to perform the necessary function (i.e. dependent upon the vividness of the information, recognition memory will use the received information to achieve remembering or knowing).

Despite the sensory modalities serving the same purpose of information retrieval, there is evidence to suggest that the visual domain is the superior sensory modality, followed in order by the auditory, somatosentory, gustatory, olfactory modalities (See Mozilic et al., 2012 for a review). It has been repeatedly argued that the visual domain is the superior sensory modality, due to there being more visual information available in an environment for an individual to interpret than other sensory information (Mozilic et al., 2012). This notion of the visual sensory modality has been used in two studies to compare visual and auditory recognition memory (Cohen et al., 2009; 2011). For instance, Cohen et al (2009) conducted two recognition memory experiments, the first experiment presenting one set of participants with visual pictures of objects such as a kettle or a dog and the other presenting another set of participants with the auditory sounds to the visual pictures (i.e. the sound of a kettle boiling and a dog barking). The participants in each experiment had to indicate whether they had seen an item in the study phase by stating *old* (the item was in the study phase) and *new* (the item was not in the study phase). These studies concluded that the auditory experiments produced less correct recognition responses than the visual experiments, demonstrating that recognition memory tends to select visual items as there is more accessible information for achieving recognition (Cohen et al., 2009; 2011).

Nevertheless, the conclusions reached by Cohen et al (2009) and Cohen et al (2011) should not be immediately accepted, as it does not provide evidence to suggest whether visual items actually produce more remember response than auditory items. Furthermore, the participants were not asked to elaborate on their responses, so the researchers cannot assess whether more detail is recalled for the auditory items. These criticisms could theoretically be answered by the remember/know procedure, because remember responses are recorded and confirmed by a participant's description of why they remember an item being presented in the study phases. However, only one study has tested auditory recognition memory using the remember/know procedure and even then, it was not conducted with the intentions of comparing sensory modalities or measuring auditory recognition memory performance for a non-clinical sample (i.e. auditory recognition memory was examined on individual's with Schizophrenia) (Drakeford et al., 2006). As a result, there is no clear indication that visual recognition memory is superior to auditory recognition memory.

1.9. Rationale for the Present Study

1.9.1. Summary

To summarise the previously discussed literature, the remember/know procedure is popular amongst dual-process researchers for measuring the two perceived processes of recognition memory, recollection and familiarity (e.g. Wixted & Mickes, 2010). Based on the research that has used the remember/know procedure, there was evidence to suggest that remember responses (which reflects recollection) are increased by emotional items (positive and negative) (Schmid and Mist, 2010), particularly when the

emotional items are measured on the characteristic of valence (e.g. Kensinger & Corkin, 2003; Oschner, 2000) whilst controlling for the level of arousal (Kensinger, 2008). However, when the effects of emotional items on remembering are applied to the study of adult aging, contradictory results have emerged. For instance, research such as Isaacowitz et al (2006) found younger adults remember more negative items and older adults remember more negative items, whereas Kensinger (2009) found younger adults remember more positive items. Consequently, there is insufficient evidence to reveal the effects positive and negative valence items have on the remember performance of younger and older adults when using the remember/know procedure.

The remember/know procedure continues to remain a popular measure with Wixted & Mickes (2010) stating that in 2009 alone, over 30 publications implemented the remember/know procedure into recognition memory research. This continual use of the remember/know procedure could signify that to reach a conclusive understanding on aging and remembering, dual-process researchers will implement the remember/know procedure in its current form, and will propose that results that demonstrate differences in younger and older adults remember responses are the result of cognitive decline (Davidson & Glisky, 2002; Denburg et al., 2003; Kensinger et al., 2002; Old & Naveh-Benjamin, 2008; Otani et al, 2007). However, there could be other explanations for the incompatible findings into the effects emotional items have on aging and remembering, which may not be the consequence of a deficit in the available remember/know input. In fact, there could be other possible reasons for this inconsistency. For example, the proposed underestimation of the know

responses in the remember/know procedure (e.g. Jacoby et al., 1997), younger and older adults self-regulating emotional items differently (Socioemotional selectivity theory- Charles et al., 2003), or the differing response biases that younger and older adults have displayed during recognition memory experiments (e.g. Basten & Van der Linden, 2003), could be the factors that have varied the results of previous studies. Indeed, these other potential factors have also produced similarly conflicting findings when attempting to measure aging and remembering. For instance, Lawton et al (1992) found older adults remember positive items better than younger adults, whereas Lawton et al (1993) found older adults to be particularly unable to self-regulate the remembering of positive emotions. Nevertheless, they offer different theoretical concepts to the impact emotions on aging and remembering, to which have not been concurrently tested within the same study before.

In addition, previous recognition memory research has focused on investigating the visual effects of emotions on aging and remembering, even though human are known to possess five sensory modalities that are capable of perceiving environmental items (i.e. an individual can see, hear, touch, taste and smell items presented to them in an environment) (Kung, 2005). There are a couple of studies that have indicated that when visual and auditory recognition memory performance is compared, the visual demonstrates more correct recognition responses than the auditory modality (Cohen et al., 2009; 2011). Yet, these studies did not use the remember/know procedure, which theoretically is required for understanding any discrepancies in remember responses between the visual and auditory modalities. Currently, only one study has measured

auditory recognition memory performance using the remember/know procedure (Drakeford et al., 2006). Nevertheless, the study by Drakeford et al (2006) did not directly compare the visual and auditory modalities nor did it test auditory recognition memory on a non-clinical participant sample.

1.9.2. Other Issues that will Considered in relation to the Aim of the Present Study

Prior to stating the primary aim, the experiments and the hypotheses to be implemented into the present study, there are three issues that the previous research does not appear to consider, which the author proposes are essential when examining the impact of emotion on remembering across adult aging.

1.9.2.1. Measuring Recognition Memory Performance Across Adult Aging using the Early, Middle and Late Adulthood Age Categories

The previous research on emotion, aging and remembering has compared the number of correct remember responses between younger and older adults, with the intention of demonstrating the life span of remembering throughout a human's existence (Kensinger, 2011). For instance, if older adults consistently have a decrease in remember responses for emotional items in contrast to younger adults, then this pattern of results could suggest that the remembering of emotional items is not maintained throughout the process of human aging. Effectively, by revealing the levels of remembering between younger and older adults, an individual should be able to predict the progression of their ability to remember (Kensinger, 2011).

However, the transition of aging from younger to older adulthood is achieved through stages, with the stage interconnecting younger to older adulthood being known as ‘middle-age’. Taking into consideration that there is a middle stage to adult aging and that there appears to be differences in the levels of remembering between younger and older adults, middle-aged individuals should theoretically have a level of remembering that is between the levels of remembering demonstrated by younger and older adults. For instance, if younger adults have the highest level of remembering and older adults the lowest, then middle-aged adults should have a level of remembering lower than younger adults, but higher than older adults. Unfortunately, there is not much evidence on the capacity of remembering for middle-aged adults, thus a complete sequence of adult human remembering cannot be predicted.

Therefore, the present study will measure younger, middle-age and older adult’s recognition memory performances, with the intention of producing results that will indicate any linear pattern for the correct number remember responses across the three age groups (e.g. a decrease in remembering from younger to middle-age adults, and a decrease in remembering from middle-aged to older adults). To note for the present study, younger, middle-aged and older adults will be assigned to age categories referred to as Early Adulthood (younger), Middle Adulthood (middle-aged), and Late Adulthood (older).

1.9.2.2. Measuring Recognition Memory Performance for Positive, Negative and Neutral Valence (Neutral Arousal) Items

With there being a main focus to report the differences in the remembering of positive and negative items between younger and older adults, there is not much evidence to suggest the impact neutral items have on aging and remembering. Fundamentally, neutral items are assumed to be aspects of an environment that are neither perceived to be positive or negative to an individual and so are considered not to take precedence over the emotional importance of remembering positive or negative items (e.g. Ohman et al., 2001; Phelps, 2006). Nevertheless, because positive and negative items are remembered more effectively then neutral items, does not necessarily mean individuals will not on occasions remember neutral items more than positive or negative items. In fact, some neutral items may have more importance to an individual than positive or negative items. For instance, an arguably neutral item such as the word ‘paper’ may elicit remembering in comparison to a negative item such as ‘gangrene’, because an individual can associate the word paper with an aspect of their life such as their job, whereas the word gangrene has no representation within an individual’s everyday encounters. Consequently, the present study will include the presentation of neutral valence (neutral arousal) items along with positive and negative (neutral arousal) items within the experimental procedures, so that the differences in the remembering of positive, negative and neutral items can be observed for the Early, Middle and Late Adulthood groups.

1.9.3. Primary Aim of the Present Study

The primary aim of the present study is to investigate the impact emotional valence (positive, negative, neutral) with neutral arousal items has on the visual and auditory recognition memory performance (remember and know responses), response bias and self-relevance scores of participants that represent the three adult age groups; Early, Middle and Late Adulthood.

1.9.3.1. The Visual Standard and Modified and Auditory (Standard and Modified) Remember/Know Experiments

The visual and the auditory standard and modified experiments were designed to examine the validity of past findings concerning the effects of; positive and negative valence items (each valence type is of neutral arousal i.e. is considered to be neither calming nor exciting) on younger and older adults visual and auditory recognition memory performance, the underestimation of know responses using the remember/know procedure and differences in response bias between younger and older adults. To accomplish these aims, remember, know and response bias measures were compared between the 'standard' visual and auditory remember/know experiments (Tulving, 1985; Gardiner., 1988) and the 'modified' visual and auditory remember/know experiments (Sheridan & Reingold, 2011) which has been included fundamentally because it argues that 'regardless of whether or not a result is shown to be significant, the modified remember/know procedure should produce consistent results for know responses' (Sheridan & Reingold, 2011, p. 1340)

1.9.3.2. The Visual Standard and Modified (Standard and Modified) Self Relevance Questionnaires

To measure the visual and auditory self-relevance scores for the participants used within the present study, standard and modified self-relevance questionnaires that have been designed based on the emotional valence (neutral arousal) items presented within the study phases of the standard and modified remember/know experiments, respectively. These self-relevance questionnaires will be given to the participants within each age group to complete immediately after the participants have completed the standard and modified remember/know experiments (e.g. the participants will complete the standard self-relevance questionnaire immediately after they have completed the standard remember/know experiment).

1.9.4. Hypotheses

The following predictions have been made with regards to the primary aim of the present study;

I. There will be a significant difference in the number of correct remember words for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)

II. There will be a significant difference in the number of correct know words for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)

III. There will be significantly more correct remember responses for the visual standard and modified experiments in contrast to the auditory standard and modified remember/know experiments for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood).

IV. There will be more correct know responses for the visual and auditory modified experiments in comparison to the visual and auditory standard experiments for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)

V. There will be a significant difference in liberal and conservative response bias for each of the emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood).

VI. There will be a significant difference in the self-relevance scores for each of the emotional valence (neutral arousal) types (positive, negative and neutral) across the age groups (Early, Middle and Late Adulthood).

2. Standard and Modified Visual Remember/Know Experiments Methodology

2.1. Participants

Forty-eight participants from geographical locations within Northern England (United Kingdom) were selected for this study using opportunity sampling. An inclusion/exclusion criteria was implemented which meant that individuals could not participate if they had any of the following; neurological illness or trauma (e.g. head injury), a psychiatric history (i.e. an on-going psychological complaint such as schizophrenia), or had a first degree relative (e.g. parent) that had been diagnosed with clinical depression. Furthermore, all the participants spoke English as their first language, had no hearing problems and had normal or corrected vision.

Participants were assigned to an experimental condition according to their age. The experimental groups and age ranges were characterised as follows; age 20-39 Early Adulthood (EA), ages 40-59 Middle Adulthood (MA), ages 60 and above Late Adulthood (LA). Table 1 provides the means, standard deviations, age ranges and gender ratios for the three experimental groups participating in the standard and modified visual remember/know experiments.

Table 1- Gender Ratios, Means, Standard Deviations (SD), and Age Ranges for the visual Standard and Modified remember/know experimental age group (EA = Early Adulthood, MA= Middle Adulthood, and LA = Late Adulthood).

Standard and Modified Visual Remember/Know recognition memory test	**Ratio**	
Males/Females EA	**10/6 (n=16)**	
Males/Females MA	**9/7 (n=16)**	
Males/Females LA	**5/11 (n=16)**	
Age Categories	**Mean (SD)**	**Range**
Age of the EA participants (in years)	**27 (4.97)**	**21-37**
Age of the MA participants (in years)	**49 (5.16)**	**41-59**
Age of the LA participants (in years)	**66 (4.18)**	**61-74**

2.2. Project Ethics

To ensure that the participants remained anonymous throughout the data collection, the participants were each assigned a ‘participant number’ prior to commencing the study. The participants were instructed to retain this number in the event that they wanted to withdraw their data before the results analysis was completed, as their personal details (i.e. name) were not recorded. Once the analysis of the results had been completed the participants were told that they were unable to withdraw their results, however, they were also informed that they would maintain their anonymity even if the study was to be published as a journal article. All the participants for this study were volunteers and

confirmed their participation by providing written and informed consent (see Appendix 1 for the template of the consent form used).

This study was approved by the University of Huddersfield's School of Human and Health Sciences research ethics panel, which abides by the 1998 data protection act set out in the British Psychological Society's ethical guidelines for researchers (British Psychological Society, 2009).

2.3. Experimental Design

2.3.1. Repeated Measures Design

The present study used a repeated measures design so that the participants within the experimental age groups EA, MA and LA could be examined using the standard and modified remember/know models, under the three emotional valence groups of positive, negative and neutral items.

2.3.2. The Levels of the Independent Variable and Dependent Variables

The independent variable of adult age had three levels of age category (age groups; Early adulthood- EA, Middle adulthood- MA, and Late adulthood- LA), which were measured with regards to the two dependent variables of standard and modified remember/know recognition memory models.

2.3.3. Increasing the Reliability of the Results when using a Repeated Measures Design

In advance of commencing this study, it was anticipated that operating experiments using a repeated measures design could present issues that have

a consequence on the reliability of the results obtained. These issues associated with using a repeated measures design are often referred to as order effects and have been understood as potentially affecting the independent and dependent variables of a study merely because of the order the participants observe the experimental procedure (Gavin, 2008). Previous research has indicated that if all the participants complete the experimental procedure in the same way, then the outcomes of the study becomes susceptible to either the eventual improvement in performance due to the repetition of tasks, which can positively affect the IV and DV (i.e. improved performance because of repeated practise of tasks) or a decrease in performance attributable to fatigue that can negatively affect the IV and DV (i.e. the duration of tasks causes the participants to become tired or disinterested, thus decreasing performance) (see Cozby, 2009 for a review). Indeed, there are other problems that can arise from using a repeated measures design such as events experienced prior to completion of the experiments may alter how the participants respond to the presented items (i.e. experiencing external factors outside of the experiment could change the participants receptiveness to towards how they remember the positive, negative or neutral items). However, the issue of external influences on participant's responses is virtually impossible to control, as researchers cannot organise the participant's everyday life. Nevertheless, the notion of practise and fatigue effects are a possibility in this study for the reasons that the participants could have repeated the same sequence for the experimental groups and the experimental designs (e.g. being presented all the positive items, then the negative, then the neutral in the standard then modified experiments), with the

participants having to complete this sequence over a prolonged period of time if it was not adequately regulated. Consequently, assuming that there was an increased possibility of practise and order effects within this study, interventions that attempted to maintain the reliability that accounted for these effects were implemented.

2.3.3.1. Practise Effect Interventions

To limit the occurrence of a practise effect, three interventions were incorporated into the study. The first intervention was the inclusion of practise tests prior to commencing either experimental test. These practise tests functioned as a means of ensuring that no matter which experimental test was performed first, the participants comprehension for the differences between remember and know responses could be assessed by the researcher before they continued onto the experimental tests.

The second intervention used the technique of counterbalancing, whereby the order of the experimental tests was achieved by 50% the participants completing the standard then modified tests, and the other 50% of participants completing the modified then standard tests. The use of this counterbalancing technique aimed to ensure that an equal amount of participants amongst the three age groups completed the standard then modified or modified then standard sequences. This would reduce bias towards one experimental test, as it would provide an average recognition memory performance that consisted of the results from the standard then modified 50% and the modified then standard 50%.

The third intervention was mixing the presentation of the three experimental group items, so that the participants did not observe consecutive words from the same experimental condition. For instance, the positive items would not be presented one after another instead a participant may observe for example a positive item followed by a neutral item. This intervention was included in this study again based on the principle of counterbalancing as the participants randomly observed the three experimental conditions (positive, negative and neutral items). This would reduce the chance of the participants learning the sequence and potentially the rationale for presented items, because it would be less probable for the participants to witness a pattern of the items emerging. For example, if all the positive items were presented together, then the participants could deduce that the researcher is testing memory for positive words, and adjust their responses in relation to this reasoning.

2.3.3.2. Fatigue Effect Interventions

To constrain the fatigue effect, it was essential to conduct each experimental test on separate days whilst maintaining the counterbalancing technique (50 % of the participants still completed either the standard then modified or modified then standard sequences, but did not complete them on the same day) and providing adequate free time for the participants to rest in between phases (i.e. the participants could request to take a ten minute break during the interval phase instead of completing the National Adult Reading Test, an assessment measure included in this study that is discussed later on). Altogether, these interventions operated the components of the study taking into account the

implications of the practise effect, while allowing the participants efficient time to rest, thus reducing the prospect of the fatigue effect occurring.

In addition, during the study of the standard and modified experiments, the participants were instructed to state aloud after each word whether they perceived the word to be ‘pleasant’ or ‘non-pleasant’. This technique aided concentration on the items because the participants had to be aware of the items being presented, therefore preventing them from losing interest.

2.4. Apparatus

2.4.1. Personal Computer (PC) for the Visual Standard and Modified Experiments

To create the visual standard and modified experiments, Superlab 4.0.7 was operated using Windows 7 on a standard lab PC, which had an Intel Core i3 duo processor, RAM size 3GB. To display the items within the experiments, a 17 inch LCD monitor screen was used.

2.4.2. Laptop for the Visual Standard and Modified Experiments

Superlab 4.0.7 was operated using Windows 7 on a Toshiba satellite pro L630-166 laptop, which had an Intel Corei3 duo processor, RAM size 2GB. The items within the experiments were displayed on the integrated 13.3 inch LCD screen.

2.4.3. The Keypad Responses for the Standard Experiment

To record yes-no and remember-know responses, the participants were asked to use an experimental keypad. The experimental keypad was colour and label

co-ordinated, so that the yes-no and remember-know responses were individually identifiable to the participants. There were a total of four responses available to the participants (see Appendix 2 for the standard experimental keypad responses).

2.4.4. The Keypad Responses for the Modified Experiment

Comparable to the standard experimental keypad, the modified experimental keypad were colour and label co-ordinated. Since the test phases for the standard and modified experiments varied, it required the exclusion of the yes-no responses and instead incorporated remember, know and new responses. In addition, top and bottom responses were included (for the forced-choice aspect of the modified experiment), with a total of five responses being available to the participants (see Appendix 3 for the modified experimental keypad responses).

2.5. Materials

2.5.1. Assessment Measures

2.5.1.1. Positive and Negative Affective Scale (PANAS)

The PANAS is a psychometric measurement comprising of two mood scales that are widely utilised in psychological research for obtaining separate overall positive and negative scores. These positive and negative scores are then evaluated, with the highest scoring mood scale then being considered to be a representation of an individual's mood state for the previous few weeks. For instance, a higher positive score indicates an increased positive mood, whereas

a higher negative score indicates an increased negative mood (Watson et al., 1988).

To achieve the separate mood scores, the PANAS consists of ten positive and ten negative single word items (twenty word items in total) that each use a five point scale ranging from 1 (very slightly or not at all) to 5 (extremely), so that an individual can rate the extent to which a word has been associated with their predominant mood state prior to commencing the PANAS (Watson et al., 1988). The total scores ranged from the lowest scoring of ten (if a participant scored each of the 10 word items on the positive or negative scales ‘one’) to the highest scoring of 50 (if a participant scored each of the ten word items on the positive or negative scales ‘five’), with a higher total score for either the positive or negative scales indicating that there was an increased association with that specified mood state.

For this study, every participant was asked to complete the PANAS prior to commencing the experimental tests on separate days, which meant that two sets of PANAS scores were obtained for each participant (i.e. the participants had two positive scores and two negative scores). The two positive scores and the two negative scores were then added together (i.e. the two positive scores were added together, and the two negative scores were added together) and divided by two, so that an average positive score and an average negative score was attained for each participant for both experimental tests. Table 2 below, displays the Early, Middle and Late Adulthood groups PANAS scores for the visual standard and modified remember/know experiments.

Table 2- The Means and Standard Deviations (SD) for the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) groups Visual Standard and Modified PANAS Scores

PANAS Mood States	***Standard PANAS Scores***			***Modified PANAS Scores***		
	EA	***MA***	***LA***	***EA***	***MA***	***LA***
	Means (SD)	***Means (SD)***	***Means (SD)***	***Means (SD)***	***Means (SD)***	***Means (SD)***
Positive PANAS Scores	***40(5.04)***	***40(4.14)***	***41(2.89)***	***40(2.53)***	***39(4.06)***	***41(2.60)***
Negative PANAS Scores	***18(2.99)***	***17(3.01)***	***18(4.01)***	***16(3.94)***	***17(2.11)***	***18(2.49)***

Indeed, with only positive and negative mood scores being able to be obtained from using the PANAS, there is often the assumption that the PANAS scores would be unnecessary when used in emotion research. Primarily, this is because for example, if an individual remembers more positive or negative items, then it could be argued that the results were a consequence of the PANAS scores indicating either a higher positive or negative mood state. Effectively, some researchers such as Costa and McCrae (1980) argued that the PANAS scale was missing a ‘neutral’ category, to which researchers that are examining mood and emotion should aim to attain scores within for non-clinical samples. Nevertheless, research such as Crawford and Henry (2004) argued that in a non-clinical sample, it is ideal to achieve a proportionately higher positive PANAS score, because a proportionately higher negative score is associated with a clinical sample such as individuals with depression. If a neutral category was created and PANAS scores were within it, then it could be argued that at the time of the experiment, an individual is expressing a mood

state that is neither representative of a clinical or a non-clinical sample (Crawford & Henry, 2004).

2.5.1.2. National Adult Reading Test (NART)

The NART is a commonly used method in neurological research for estimating a premorbid intelligence level in patients with dementia that speak English as their first language (assumed IQ before the onset of a neurological illness) (Nelson, 1982). The NART consists of a list of fifty words, to which the participants were instructed to read the words out aloud, focusing on the pronunciation of each word. For every word pronounced incorrectly, the participants attained an error score of one, with the possibility of being able to achieve an error score ranging between zero (a participant pronounces all the words correctly) and 50 (a participant does not pronounce any of the words correctly). These error scores were then calculated and matched to an equivalent predicted IQ performance score (see Nelson, 1982 for the equivalent predicted IQ performance scores). The predicted IQ scores have been deemed as having an increased accuracy for measuring an individual's intelligence level instead of assuming intelligence on the basis of an individual's academic background (e.g. degree classification) (Nelson, 1982).

Table 3 below, displays the visual standard and modified remember/know predicted IQ performance scores using the NART, for the participants in the visual standard and modified Early, Middle and Late Adulthood groups.

Table 3- The Predicted Visual Standard and Modified Remember/Know IQ Performance Scores for the Early, Middle and Late Adulthood Groups

Predicted IQ Performance Scores for the Three Age Groups	**Visual Standard and Modified Remember/Know Experiment** **Means (SD)**
Early Adulthood	**112 (3.33)**
Middle Adulthood	**112 (2.11)**
Late Adulthood	**114(2.73)**

From Table 3, it can be observed that the participants in each of the three age groups had a NART score that was within the stated 'normal' IQ performance range (i.e. 85-115). To note, the predicted IQ performance scores produced by the NART were not measured within the statistical analysis, because measuring IQ performance was not the focus of this study.

2.5.1.3. The Valence and Arousal Scale (VAS)

The VAS is an assessment measure that was created exclusively for this study, so that a variety of two syllables (disyllable) words could be rated with regards to their perceived emotional valence type (positive, negative or neutral) and arousal level (is an item of high, low or neutral arousal) and then could be implemented for the practise and experimental tests. Disyllable words were selected for the VAS primarily because it avoided irregularities between each item that could have increased recognition performance due to the unique differences between the items (Kern et al., 2005)

The VAS adopted a comparable technique used in Bradley and Lang's 'Affect Norms for English words' (ANEW) (1999), which meant that the participants were asked to rate the stimuli between a score of one to nine for valence (1 equalling a high negative valence score and 9 equalling a high positive score), and a score of one to nine for arousal (1 equally a low arousal score and 9 equally a high arousal score). This rating technique was explained to the participants verbally by the researcher using a set of instructions and examples prior to completing the VAS. The VAS was given to fifteen individuals that corresponded to the three adult age conditions (i.e. Early, Middle and Late Adulthood groups) being measured in the standard and modified visual recognition memory tests. These individuals only participated in the VAS and not in the standard and modified experiments.

An item represented one of the valence conditions, if it achieved a valence score that was within the range for the valence condition. The ranges for the valence conditions were equally distributed between the VAS ratings one to nine and are displayed in Table 4 below;

Table 4- The VAS Ranges for the Three Valence conditions

Valence Condition	Range scores
Negative	**1-3**
Neutral	**4-6**
Positive	**7-9**

To produce a ‘neutral’ arousal rating, any valence items that achieved an arousal score that was between four to six on the nine point VAS scale were considered to be of neutral arousal. For instance, the positive, negative and neutral valence items used have a neutral arousal mean score that is between four and six.

2.6. Experimental Items

2.6.1. Practise Test Items

Before commencing the standard and modified experiments, the participants within the three groups completed a shortened version of the experimental models. These shortened versions functioned as practice tests for the participants, but did not include the same stimuli as used in the standard and modified experiments. This avoided the participants from experiencing and potentially achieving an increase in remember or know hit rates due to the repetition of practise and experimental stimuli (i.e. correctly identifying stimuli in

the test phases of the experimental models because they have been recognised after the completion of the practise tests). Nevertheless, the stimuli in the practise tests did utilise the same criterion as the experimental test stimuli (the stimuli were equally divided to represent words that were of positive, negative and neutral valence, had a neutral arousal range and were disyllable words), with the purpose of assisting the participants in understanding the procedure (there were study, interval and test phases) and responses for the standard and modified experiments. The stimuli for these practise tests are discussed in detail under the next subheadings;

2.6.1.1. Standard Practise Items

The standard practice experiment had a study and test phase that lasted for approximately five minutes in duration. Within the study phase, the items were a combination of two positive, two negative and two neutral (total of six items) disyllable visual words (i.e. the target items). Within the test phase, the six visual target words and another six positive, negative or neutral disyllable distracter words (total of twelve words- four positive, four negative and four neutral) were randomly presented to the participants. These standard practise test items were chosen from the VAS assessment measure. Table 5 illustrates the separate mean and standard deviations for the total positive, negative and neutral valence and arousal VAS rating scores for the standard practise experiment items;

Table 5- The Mean and Standard Deviations (SD) for the Target and Distracter Valence and Arousal Scores for the Three Standard Experimental Conditions Practise Items.

Target Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**8.79 (1.41)**	**5.26 (0.78)**
Negative	**2.13 (0.59)**	**5.67 (0.96)**
Neutral	**4.75 (0.37)**	**4.23 (0.51)**
Distracter Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**8.69 (1.32)**	**5.56 (0.79)**
Negative	**2.34 (0.65)**	**5.67 (0.96)**
Neutral	**4.33 (0.37)**	**4.14 (0.51)**

From the mean scores presented in table 5, the six target and six distracter words used in the standard practise experiment were within the positive (7 to 9), negative (1 to 3) and neutral (4 to 6) valence categories, and were also within the neutral arousal range (4 to 6).

2.6.1.2. Modified Practise Items

The modified practice test had a study and test phase that lasted for approximately ten minutes in duration. Within the study phase, the items were a combination of two positive, two negative and two neutral (total of items) disyllable visual words (i.e. the target items). Within the test phase, the six visual target words and another six positive, six negative and six neutral disyllable distracter words (total of eighteen words) were randomly presented to the participants. These modified practise test items were chosen from the VAS assessment measure. Table 6 indicates the mean and standard deviations for

the total positive, negative and neutral valence and arousal VAS rating scores for the modified practise test items.

Table 6- The Mean and Standard Deviations for the Target and Distracter Valence and Arousal Scores for the Three Modified Experimental Conditions Practise Items.

Target Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**8.64 (1.29)**	**5.55 (0.93)**
Negative	**2.39 (0.66)**	**5.91 (1.02)**
Neutral	**4.61 (0.33)**	**4.13 (0.47)**
Distracter Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**8.23 (1.15)**	**5.55 (0.93)**
Negative	**2.69 (0.82)**	**5.03 (1.07)**
Neutral	**4.55 (0.65)**	**4.55 (0.45)**

From the mean scores presented in Table 6, the six target and eighteen distracter words used in the modified practise experiment were within the positive (7 to 9), negative (1 to 3) and neutral (4 to 6) valence categories, and were also within the neutral arousal range (4 to 6).

2.6.2. Experimental Test Items

2.6.2.1. Standard Test Items

The standard test experiment had a study and test phase that lasted for approximately 40 minutes in duration. Within the study phase, the items were a combination of 20 positive, 20 negative and 20 neutral (total of 60 items) disyllable visual words (i.e. the target items). Within the test phase, the 60 visual

target words and another 60 positive, negative or neutral disyllable distracter words (total of 120 words- 40 positive, 40 negative and 40 neutral) were randomly presented to the participants. These standard test items were chosen from the VAS assessment measure. Table 7 illustrates the separate mean and standard deviations for the total positive, negative and neutral valence and arousal VAS rating scores for the standard test experiment items;

Table 7- The Mean and Standard Deviations (SD) for the Target and Distracter Valence and Arousal Scores for the Three Standard Experimental Conditions Test Items.

Target Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**8.48 (2.12)**	**5.29 (1.89)**
Negative	**2.49 (1.77)**	**5.66 (1.99)**
Neutral	**4.64 (1.35)**	**4.44 (1.52)**
Distracter Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**8.10 (1.30)**	**5.01 (1.93)**
Negative	**2.39 (1.66)**	**5.91 (1.02)**
Neutral	**4.61 (2.33)**	**4.13 (1.47)**

From the mean scores presented in Table 7, the 60 target and 60 distracter words used in the standard test experiment were within the positive (7 to 9),

negative (1 to 3) and neutral (4 to 6) valence categories, and were also within the neutral arousal range (4 to 6).

2.6.2.2. Modified Test Items

The modified test had a study and test phase that lasted for approximately 60 minutes in duration. Within the study phase, the items were a combination of 20 positive, 20 negative and 20 neutral (total of items) disyllable visual words (i.e. the target items). Within the test phase, the 60 visual target words and another 60 positive, 60 negative and 60 neutral disyllable distracter words (total of 240 words) were randomly presented to the participants. These modified practise test items were chosen from the VAS assessment measure. Table 6 below, indicates the mean and standard deviations for the total positive, negative and neutral valence and arousal VAS rating scores for the modified test items.

Table 8- The Mean and Standard Deviations (SD) for the Target and Distracter Valence and Arousal Scores for the Three Modified Experimental Conditions Test Items.

Target Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**7.98 (1.72)**	**5.14 (2.02)**
Negative	**1.83 (2.11)**	**5.33 (1.99)**
Neutral	**5.00 (0.73)**	**4.53 (1.94)**
Distracter Item type	**Valence** Mean (SD)	**Arousal** Mean (SD)
Positive	**8.04 (1.07)**	**5.59 (1.44)**
Negative	**2.69 (1.48)**	**5.23 (1.39)**
Neutral	**4.81 (1.68)**	**4.21 (1.91)**

From the mean scores presented in table 8, the 60 target and 180 distracter words used in the standard practise experiment were within the positive (7 to 9), negative (1 to 3) and neutral (4 to 6) valence categories, and were also within the neutral arousal range (4 to 6).

2.6.2.3. The Inclusion of Additional words within the Experimental Test Items

In addition to the target words that were selected, twelve additional words were integrated into the study phases of the experimental tests. These additional words were presented in blocks of six, with six being shown before the target

words appeared and six appearing after the target words had been shown. Once more, these additional words were acquired from the VAS assessment measure and proportionally represented the valence measures of positive, negative and neutral (i.e. there was four of each valence type) and had a neutral mean arousal score.

The positioning and features of the additional words within the study phases was deliberate, as it complied with collective evidence that suggests additional items can be a valuable device for reducing primary and recency memory effects. Primary and recency memory effects refer to an individual's recall accuracy increasing for target items at the beginning and at the end of a study list, because of cognitive bias that arises due to processes such as heuristics (Sheridan & Reingold, 2011). For example, learning to remember the beginning and the end of a study list because of experience based problem solving, which denotes that there is an increased chance of remembering the middle of the study list if the beginning and end is known) Therefore, by applying additional words, the participants will be limited in learning the study phase stimuli based on the presentation of the first and last few words.

2.7. Procedures

2.7.1. Pilot Studies for the Visual Standard and Modified Experiments

Pilot studies were administered to an additional six participants. Both the standard and modified pilot studies were assigned three of the six participants, with each one of the three participants representing either the early, middle or late adulthood groups. This distribution of pilot participants are identical to the

selection criteria for the experimental models (i.e. standard and modified) and was practical in limiting potential design issues from appearing during the standard and modified tests (Ruxton & Grove, 2006). For instance, the pilot studies identified the necessity for the participants completing the standard and modified experiments on separate days as the total time when the experiments were completed on the same day was approximately two hours thirty minutes, which could have increased the probability of the fatigue effect. The data attained from these pilot studies were excluded from the statistical analysis.

2.7.2. Standard Remember/Know Experimental Procedure

Prior to participating in the standard remember/know experiment, each participant was provided with participant information (see Appendix 4). On the day of the experiment, the participants were asked to firstly complete the PANAS assessment measure. Immediately after completing the PANAS, a set of standardised instructions was given to the participants, reiterating the participant information and explained the key features between remember and know responses. An example of an everyday situation to which remember and know responses are observable within was discussed (i.e. the participants were read the example, asked if they had experienced a similar situation and then were asked to describe an occasion when they had experienced a feeling that represents remember and know), and a practise test was completed by the participants to ensure that they thoroughly understood the experimental procedure and the difference between remember/know responses.

Following on from the practise test, the participants began to view the 60 target items within the study phase. These items were presented individually, at a presentation rate of 1500 milliseconds (ms) and an inter-stimulus interval rate of 2000 ms. To sustain concentration on the presented items, the participants were instructed to state aloud whether they thought the target items were pleasant or non-pleasant, even if the item was of neutral valence. To note, these responses for the target items were not recorded and the participants were tested individually.

Between the study and test phases, a timed (using a stopwatch) ten minute interval phase was incorporated, during which the participants completed the NART.

The difference in tasks completed during the interval phase and the variation in concluding procedures after the remember/know experiments was dependent on the implemented counterbalancing technique, and so reflected the order to which the participants had completed the standard and modified remember/know experiments (i.e. standard then modified, or modified then standard).

The participants then undertook the test phase of the study. For the test phase, the 60 target words from the study phase were mixed with 60 supplementary distracter words, which were once more presented individually at a rate of 1500ms. However, after each word was presented, the participants were instructed to indicate the target words from the distracter words by pressing on an experimental keypad ‘Yes’ if they recognised the word, and ‘No’ if they did

not recognise the word. The participants were allocated 3000ms time frame to respond before the next word was shown. If the participants responded ‘No’ then the next word was instantly presented. Nevertheless, if the participants responded ‘Yes’, regardless of whether it was target or distracter word, then they were asked to indicate the basis of the recognition (remember or know). To record remember or know responses, the participants had to select ‘R’ for remember and ‘K’ for know on the experimental keypad. The remember/know element of the study did not have a time limit. Nonetheless, the participants were encouraged to respond promptly with the reason for their recognition selection (i.e. verbally explain why they felt they remembered a word, before pressing the ‘R’ button). These verbal explanations for the remember and know responses were not recorded.

Following the test phase of the standard remember/know experiment, the participants either arranged another day to complete the modified remember/know experiment or if they had already completed the modified version, then they were debriefed and any questions with regards to the study were addressed (See Appendix 5 for the standard remember/know debrief).

2.7.3. Modified Remember/Know Experimental Procedure

Up to the end of the modified interval phase, the stages completed for the standard and modified remember/know experiments were similar (i.e. the participants again completed the PANAS assessment measure, a practise test etc). To note, the NART is completed again during the interval phase of the modified remember/know experiment. However, depending on the order to

which the participants completed the standard and modified remember/know experiments (i.e. standard then modified or modified then standard) the NART score for the first remember/know experiment they complete will be recorded as their achieved NART score. For instance, if a participant completes the standard remember/know experiment first then the NART completed during the interval phase of the standard remember/know experiment will be recorded as the participants achieved NART score.

However, primarily because of the 2AFC component of the modified experiment, when the participants reached the test phase, the 60 target items from the study phase were mixed with a further 180 distracter words and presented two words at a time, with one word being above the other in the centre of the laptop or computer screens. This arrangement meant that 50% of the presented items had two distracter words presented together (i.e. the participants had not observed these words in the study phase) and the other 50% of presented items had one target word and one distracter word. Therefore, the participants were firstly asked to identify from the two words presented whether they perceived either of the words to be remembered, known, or new. This selection was achieved by pressing either one of the ‘R’, ‘K’ or ‘N’ buttons on the experimental keypad. Once a remember, know or new response was recorded within a 3000ms time frame, the participants were then instructed to choose the word at the top or the word at the bottom, with the selection being made by pressing the ‘up’ or ‘down’ buttons on the experimental keypad.

Following the test phase of the modified remember/know experiment, the participants were debriefed and any questions with regards to the study were addressed (See Appendix 6 for the modified remember/know debrief).

2.8. Performance Measures

2.8.1. Response Bias C Measure

The response bias measure employed in the present study is the parametric measure of 'C' (for criterion level) proposed by Ingham (1970). The calculation for C is expressed as follows;

$$C = -0.5\,[z(H) + z(F)]$$

It has been suggested by signal detection theory (single process) that correct responses referred to as hit rates (H) and the incorrect responses referred false alarm rates (F) (this study uses the terms incorrect and incorrect remember or know responses) can be added to 0.5 and then divided by the total number of items (there are twenty items in each of the valence conditions) plus 1. From this procedure, z scores are produced for each of the correct and incorrect responses (i.e. scores that indicate whether a correct or incorrect score was above or below the mean score achieved), which can then be added together and multiplied by -0.5 to attain a response bias score (as denoted in the above calculation). Indeed, there are other response bias calculations that have been proposed such as β (see Banks, 1970; Macmillian and Creelman, 1990; Snodgrass & Corwin, 1988 for more information on β). However, the C calculation is considered to calculate liberal and conservative response bias based on the direct observation of the correct and incorrect scores, whereas

calculations such as β are considered to be ‘based on a likelihood ratio’ (Stanislaw & Todorov, 1999, pg. 140). Furthermore, by calculating the z scores in this way, the response bias C calculation appears to offer scores that clearly indicate the strength to which participants are responding either more liberally or conservatively towards presented items. For instance, the response bias C calculation produces either ‘positive’ (conservative) or a ‘negative’ (liberal) scores that range from -1 to +1 (i.e. -1 and +1 are the maximum liberal and conservative scores that could be obtained). Therefore, using the C calculation to measure the Early, Middle and Late Adulthood groups response bias will provide scores that are in conjunction with previous remember/know research.

2.9. Statistical Analysis

2.9.1. Measuring the Impact of the Visual Experimental Order Effects

In addition to the interventions that were implemented in this study to limit order effects, it was decided that a statistical analysis should be conducted to ensure there was no significant effect on the results of the study. This analysis focused on examining the standard-modified and modified-standard orders of experiments that a participant could have completed the remember/know experiments in.

The results of this analysis were analysed using IBM SPSS 20. A *Shapiro-Wilks* test of normality was used because there were less than fifty participants in each of the three age groups (Coolican, 2009). From the test of normality, not all the recognition memory performance measures were normally distributed. Therefore, non-parametric *Mann-Whitney U* tests were performed on the visual

recognition memory performance measures for the three emotional valence (neutral arousal) groups.

2.9.2. Visual Remember/Know Experiments

The results for the visual standard and modified remember/know experiments were analysed using IBM SPSS 20. From the Shapiro-Wilks test of normality, not all the recognition memory performance measures were normally distributed. Therefore, three-way mixed ANOVA's were performed to examine the recognition performance measures within the visual standard and modified remember/know experiments (relating to hypotheses I, II and V), and Mann-Whitney U tests were performed to examine the recognition performance measures between the visual and auditory standard and modified remember/know experiments (relating to hypotheses III and IV).

3. <u>Standard and Modified Auditory Remember/Know Experiments Methodology</u>

3.1. The Auditory Remember/Know Methodology Replicates the Visual Remember/Know Methodology

The auditory standard and modified remember/know experiments replicate the visual standard and modified experiments, except that the positive, negative and neutral items are presented to the Early, Middle and Late Adulthood groups orally, and different participants have been recruited for participation. This replication of the visual methodology meant that the apparatus, assessment measures, experimental items (practise and test) performance measures and procedures were the same for the auditory methodology.

3.2. Participants

Forty-eight participants from geographical locations within Northern England (United Kingdom) were selected for this study using opportunity sampling. An inclusion/exclusion criteria was implemented which meant that individuals could not participate if they had any of the following; neurological illness or trauma (e.g. head injury), a psychiatric history (i.e. an on-going psychological complaint such as schizophrenia), or had a first degree relative (e.g. parent) that had been diagnosed with clinical depression. Furthermore, all the participants spoke English as their first language, had no hearing problems and had normal or corrected vision.

Participants were assigned to an experimental condition according to their age. The experimental groups and age ranges were characterised as follows; age 20-39 Early Adulthood, ages 40-59 Middle Adulthood, ages 60 and above Late Adulthood. Table 9 provides the means, standard deviations, age ranges and gender ratios for the three experimental groups participating in the standard and modified visual remember/know experiments.

Table 9- Gender Ratios, Means, Standard Deviations (SD), and Age Ranges for the Auditory Standard and Modified Remember/Know experimental age group (EA = Early Adulthood, MA = Middle Adulthood, and LA = Late Adulthood).

Standard and Modified Auditory Remember/Know recognition memory test	**Ratio**	
Males/Females EA	**8/8 (n=16)**	
Males/Females MA	**5/11 (n=16)**	
Males/Females LA	**2/14 (n=16)**	
	Mean (SD)	**Range**
Age of the EA participants (in years)	**25 (5.02)**	**21-37**
Age of the MA participants (in years)	**51 (5.07)**	**41-59**
Age of the LA participants (in years)	**71 (4.51)**	**61-74**

3.3. Materials

3.3.1. NART Scores

Table 10 below, displays the auditory standard and modified remember/know predicted IQ performance scores using the NART, for the participants in the visual standard and modified Early, Middle and Late Adulthood groups.

Table 10- The Predicted Auditory Standard and Modified Remember/Know IQ Performance Scores for the Early, Middle and Late Adulthood Groups

Predicted IQ Performance Scores for the Three Age Groups	**Visual Standard and Modified Remember/Know Experiment** **Means (SD)**
Early Adulthood	**112 (3.02)**
Middle Adulthood	**113 (2.47)**
Late Adulthood	**113(4.11)**

3.3.2. PANAS Scores

Table 11 below, displays the Early, Middle and Late Adulthood groups PANAS scores for the auditory standard and modified remember/know experiments.

Table 11- The Means and Standard Deviations (SD) for the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) groups Auditory Standard and Modified PANAS Scores

PANAS Mood States	***Standard PANAS Scores***			***Modified PANAS Scores***		
	EA	***MA***	***LA***	***EA***	***MA***	***LA***
	Means (SD)	***Means (SD)***	***Means (SD)***	***Means (SD)***	***Means (SD)***	***Means (SD)***
Positive PANAS Scores	***39(3.11)***	***39(2.22)***	***40(2.33)***	***41(3.07)***	***39(4.08)***	***42(4.36)***
Negative PANAS Scores	***16(1.99)***	***17(3.69)***	***17(5.00)***	***16(3.12)***	***15(4.41)***	***17(3.59)***

3.4. Statistical Analysis

3.4.1. Measuring the Impact of the Auditory Experimental Order Effects

Again, to statistically examine the standard-modified and modified-standard sequences completed for the auditory remember/know experiments, IBM SPSS 20 was used. A *Shapiro-Wilks* test of normality revealed that not all the recognition memory performance measures were normally distributed. Therefore, non-parametric *Mann-Whitney U* tests were performed on the auditory recognition memory performance measures for the three emotional valence (neutral arousal) groups.

3.4.2. Auditory Remember/Know Experiments

The results for the auditory standard and modified remember/know experiments were analysed using IBM SPSS 20. From the Shapiro-Wilks test of normality, not all the recognition memory performance measures were normally distributed. Therefore, three-way mixed ANOVA's were performed to examine the recognition performance measures within the auditory standard and modified remember/know experiments (relating to hypotheses I, II and V), and Mann-Whitney U tests were performed to examine the recognition performance measures between the visual and auditory standard and modified remember/know experiments (relating to hypotheses III and IV).

4. Results for the Visual and Auditory Remember/Know Experiments

4.1. Means and Standard Deviations for the Visual and Auditory Remember/Know Experiments

4.1.1. Visual Standard and Modified Remember/Know Experiments

Appendix 7 Illustrates the means and standard deviations in Table 12 for the three adult age groups remember/know performance, in relation to the standard and modified visual presentation of the emotional valence (neutral arousal) items.

The following summaries will describe the pattern of results from the means expressed in Appendix 8 for the visual standard and modified remember/know experiments recognition memory performance measures.

4.1.1.1. A Summary of the Visual Standard and Modified Correct Remember Responses

Both the standard and modified remember/know experiments have shown that participant's in the Early Adulthood group produced more correct remember responses for the positive, negative and neutral valence items than the participants in the Middle and Late Adulthood groups. However, except for the Early Adulthood's negative correct remember responses in the standard and modified experiments being the same (i.e. both displayed a mean score of 13), the standard remember/know experiment showed higher correct remember scores than the correct remember scores in the modified remember/know experiment.

4.1.1.2. A Summary of the Visual Standard and Modified Correct Know Responses

For the correct know responses, there are similarities and differences between the recognition memory performance measures for the standard and modified remember/know experiments. The neutral valence items for participants in the Early and Middle Adulthood produced the more correct know responses than the positive and negative valence items. Nevertheless, the standard remember/know experiment demonstrated that participants in the Late Adulthood group had more correct know responses for the positive valence items, in contrast to the modified remember/know experiment which demonstrated that the participants in the Late Adulthood group had more correct know responses for the neutral valence items.

4.1.1.3. A Summary of the Visual Standard and Modified Response Bias Responses

The total response bias scores for the standard and modified remember and know responses were shown to be relatively similar. Indeed, the response bias scores for the positive valence items differed between the standard and modified remember/know experiments for the three age groups. However, both experiments showed that all three age groups respond more conservatively to positive valence items, which is demonstrated in the attainment of ‘positive’ response bias scores. Furthermore, both the remember/know experiments produce the same response bias scores for negative valence items whilst demonstrating a more conservative response bias for all three age groups (i.e.

Early Adulthood mean score = 0.5, Middle Adulthood mean score = 0.4 and Late Adulthood mean score = 0.3). The standard and modified remember/know experiments also achieve the same response bias scores for neutral valence items (i.e. Early Adulthood mean score = 0.4, Middle Adulthood mean score = 0.2, Late Adulthood mean score = - 0.2), yet the Early and Middle Adulthood groups produced a more conservative response bias whereas the Late Adulthood groups produce a more liberal response bias score. The liberal response bias score for the Late Adulthood group is demonstrated by the 'negative' scores.

4.1.2. Auditory Standard and Modified Remember/Know Experiments

Appendix 8 illustrates the means and standard deviations in table 13 for the three adult age groups remember/know performance, in relation to the standard and modified auditory presentation of the emotional valence (neutral arousal) items.

The following summaries describe the pattern of results from the means illustrated in Appendix 8 for the auditory standard and modified remember/know experiments recognition memory performance measures.

4.1.2.1. A Summary of the Auditory Standard and Modified Correct Remember Responses

Both the standard and modified remember/know experiments show that the participants in the Early Adulthood group had the highest number of correct remember responses for the negative valence items, with a mean score of 12. For the positive valence items, both remember/know experiments again showed

the Early Adulthood group to have the highest number of correct remember responses, with a mean score of 11. For the neutral valence items, the standard remember/know experiment indicates that both the Early and Middle Adulthood groups perform equally. However, the modified remember/know experiment shows that the Middle Adulthood group has the highest number of correct remember response for the neutral valence items, and surprisingly shows that the Early Adulthood group has an approximately 66% decrease in the number of correct remember responses for the neutral valence items in comparison to the standard remember/know experiment (i.e. the standard experiment shows that the Early Adulthood group has a mean score of 7 for the neutral valence items, whereas the modified experiment shows the Early Adulthood group to have a mean score of 3 for the neutral valence items).

4.1.2.2. A Summary of the Auditory Standard and Modified Correct Know Responses

Both the standard and modified remember/know experiments show the same mean correct know scores for all three age groups, with the Early and Middle Adulthood groups showing the highest number correct positive know scores (mean score of 6), the Middle and Late Adulthood groups showing highest number of correct negative know scores (mean score of 6), and the Early Adulthood group showing the highest number of correct neutral know scores (mean score of 9).

However, the standard and modified experiments demonstrate that the Middle Adulthood group has the least number of incorrect negative know responses

and the Early Adulthood group has the least number of incorrect neutral know responses. Nevertheless, the standard remember/know experiment indicates that the Early Adulthood group has the least incorrect positive know responses, whereas the modified remember/know experiments indicates that the Middle Adulthood group has the least number of incorrect positive know responses.

4.1.2.3. A Summary of the Auditory Standard and Modified Response Bias Responses

Both the standard and modified remember/know auditory experiments indicated that for the positive, negative and neutral valence items, the three adult age groups have produced ‘negative’ responses bias scores. These ‘negative’ response bias scores indicate that the participants in the Early, Middle and Late Adulthood groups are more likely to respond liberally to the auditory presentation of positive, negative and neutral valence items.

4.1.2.4. A Summary Comparing the Visual and Auditory Recognition Memory Performance Measures for the Standard and Modified Experiments

Appendix 9 directly compares the visual and auditory recognition memory performances measures for the three age groups, by indicating which of the visual or auditory standard and modified models has produced the most correct remember and know responses, and whether response bias scores are the same or different for the visual and auditory standard and modified experiments in table 14.

In conjunction with Appendix 9, there are conflicting results between the standard and modified experiments to suggest which sensory modality

produces more correct remember responses. For instance, the visual presentation of the emotional valence (neutral arousal) items appears to produce more correct remember responses across the three age groups for the standard remember/know experiments, whereas the auditory presentation of the emotional valence (neutral arousal) items appears to produce more correct remember responses across the three age groups for the modified remember/know experiments.

For the correct know responses, the visual and auditory modalities perform similarly in the standard remember/know experiment, and the visual modality outperforms the auditory modality for one valence condition in the modified remember/know experiments across the three age groups.

Finally, the visual and auditory modalities only produce one similar response bias score, which is for the presentation of neutral valence items in the Late Adulthood groups (i.e. both modalities indicate that participants in the Late Adulthood group are responding more liberally to the neutral valence items). For the rest of the valence conditions across the three age groups, the visual standard and modified remember/know experiments indicate that the participants are responding more conservatively (i.e. more likely to respond ‘no’ to observing an item in the study phase of the standard and modified experiments), while the auditory standard and modified remember/know experiments indicate that the participants are responding more liberally (i.e. more likely to respond ‘yes’ to observing an item in the study phase of the standard and modified experiments).

4.2. A Statistical Analysis for the Impact of Order Effects on the Visual and Auditory Remember/Know Experiments

The Shapiro-Wilks test of normality indicated that there were non-normal as well as normal distributions for the visual and auditory recognition memory performance measures that coincide with the standard-modified and modified-standard experimental sequences. Subsequently, Mann-Whitney U tests were performed on the visual and auditory recognition memory performance measures for the three emotional valence (neutral arousal) conditions.

The results of the Mann-Whitney U tests revealed that there were no significant differences between the recognition memory performance scores for the standard-modified and modified-standard experimental sequences for the visual and auditory remember/know experiments. The results are reported for each of the visual and auditory recognition memory performance measures in table 15 (see Appendix 10).

4.3. Using Three Way Mixed ANOVA's and Mann-Whitney U Tests to Examine Hypotheses I, II, III, IV and V of the Present Study

A Shapiro-Wilks test of normality showed that there were non-normal as well as normal distributions for the visual and auditory recognition performance measures in relation to the between-subject factor of age and the within-subject factor of emotional valence. Consequently, non-parametric analyses were performed on the visual and auditory recognition memory performance measures.

However, some of the hypotheses of the present study such as hypothesis I require the visual recognition memory performance measures to be compared with one another, and the auditory recognition memory performance measures to be compared with one another, without the necessity for a comparison between the visual and auditory remember/know experiments. Other hypotheses such as hypothesis III require the comparison between the visual and remember/know experiments, but only the comparison of one measure (i.e. hypothesis III aims to compare the correct know responses between the visual and auditory remember/know experiments). Therefore, non-parametric three way mixed ANOVA's were used to examine the main effects age had on the recognition memory performance measures and to determine if a significant main effect has varied between the different age groups within the visual and auditory remember/know experiments, and Mann-Whitney U tests were used to directly compare the recognition memory performance measures between the visual and auditory remember/know experiments.

4.3.1. Examining the Visual and Auditory Correct Remember responses relating to the hypothesis I using a three way Mixed ANOVA

Hypothesis I - There will be a significant difference in the number of correct remember words for each of the emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood).

4.3.1.1. Visual Standard and Modified Correct Remember Responses

A three-way Mixed ANOVA revealed that there was a significant main effect of age on the correct remember responses within the visual standard and modified remember/know experiments, $F(4,168) = 224.94$, $p = <.01$. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that the correct number of remember responses for the positive, negative and neutral items within the standard remember/know experiment was significantly higher in the Early Adulthood group than the Middle or Late Adulthood groups. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that the correct number of remember responses for the positive, negative and neutral items within the modified remember/know experiments were significantly higher in the Early Adulthood group than the Middle and Late Adulthood groups.

The results for the Scheffé post hoc criterion for correct remember responses within the visual standard and modified remember/know experiment are displayed in Table 16 below;

Table 16 - Scheffé's post hoc analyses on the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) group's positive, negative and neutral Correct Remember responses for the Visual Standard and Modified Remember/Know Experiments

Comparison Between VISUAL STANDARD Remember/Know Age Groups using Scheffé Post Hoc Criterion	**Comparison Between VISUAL MODIFIED Remember/Know Age Groups using Scheffé Post Hoc Criterion**
Positive Items **M = Means, SD = Standard Deviations**	**Positive Items** **M = Means, SD = Standard Deviations**
EA (M = 13, SD = 2.05) LA (M =10, SD = 1.87) (p = <.01)	**EA (M = 10, SD = 1.30) LA (M =7, SD = 1.50) (p = 0.02)**
EA (M = 13, SD = 2.05) MA (M =11, SD = 2.09) (p = <.01)	**EA (M = 10, SD = 1.30) MA (M =8, SD = 1.40) (p = <.01)**
Negative Items **M = Means, SD = Standard Deviations**	**Negative Items** **M = Means, SD = Standard Deviations**
EA (M = 13, SD = 2.50) LA (M = 8, SD = 1.78) (p = <.01)	**EA (M = 13, SD = 1.95) LA (M = 5, SD = 1.10) (p = <.01)**
EA (M = 13, SD = 2.50) MA (M = 11, SD = 2.15) (p = <.01)	**EA (M = 13, SD = 1.95) MA (M = 11, SD = 1.44) (p = <.01)**
Neutral Items **M = Means, SD = Standard Deviations**	**Neutral Items** **M = Means, SD = Standard Deviations**
EA (M = 7, SD = 3.61) LA (M = 4, SD = 1.27) (p = <.01)	**EA (M = 5, SD = 1.28) LA (M = 2, SD = 0.80) (p = <.01)**
EA (M = 7, SD = 3.61) MA (M = 5, SD = 1.30) (p = <.01)	**EA (M = 5, SD = 1.28) MA (M = 4, SD = 1.25) (p = <.01)**

The main effect of age on the standard and modified remember/know experiments is supported by the interaction effect between the emotional valence conditions and the age of the participant, F (4, 2.73) = 0.547, p = 0.03. Contrasts on the interaction revealed that there was a significant interactions when comparing the participants in the Early, Middle and Late Adulthood correct remember scores for the positive valence (neutral arousal) words to the negative valence (neutral arousal) words, F (1, 1.45) = 0.271, p = <.01, and to the neutral valence (neutral arousal) words, F (1, 1.45) = 0.342, p= <.01, and comparing negative valence (neutral arousal) words to the neutral valence (neutral arousal) words, F (1, 1.45) = 0.302, p = 0.04.

4.3.1.2. Auditory Standard and Modified Correct Remember Responses

There was significant main effect of age on the correct remember responses within the auditory standard and modified remember/know experiments, F (4, 36) = 9.43, p = <.01. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that the correct number of remember responses for the positive, negative and neutral items within the standard remember/know experiment was significantly higher in the Early Adulthood group than the Middle and Late Adulthood groups. Post-hoc analyses using the Scheffé post hoc criterion for significance also indicated that the correct number of remember responses for the positive and negative items within the modified remember/know experiments were significantly higher in the Early Adulthood group than the Middle and Late Adulthood groups, and for the neutral items the Middle Adulthood group had significantly higher correct remember responses than the Early and Late Adulthood groups. The results for the Scheffé post hoc

criterion for correct remember responses within the auditory standard and modified remember/know experiment are displayed in Table 17 below;

Table 17 - Scheffé's post hoc analyses on the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) group's positive, negative and neutral Correct Remember Responses for the Auditory Standard and Modified Remember/Know Experiments

Comparison Between AUDITORY STANDARD Remember/Know Age Groups using Scheffé Post Hoc Criterion	**Comparison Between AUDITORY MODIFIED Remember/Know Age Groups using Scheffé Post Hoc Criterion**
Positive Items **M = Means, SD = Standard Deviations**	**Positive Items** **M = Means, SD = Standard Deviations**
EA (M = 11, SD = 3.15) LA (M =10, SD = 1.89) (p = <.01)	**EA (M = 11, SD = 2.05) LA (M = 10, SD = 1.07) (p = 0.03)**
EA (M = 11, SD = 3.15) MA (M =9, SD = 2.06) (p = <0.01)	**EA (M = 11, SD = 2.05) MA (M =10, SD = 1.50) (p = 0.02)**
Negative Items **M = Means, SD = Standard Deviations**	**Negative Items** **M = Means, SD = Standard Deviations**
EA (M = 13, SD = 2.50) LA (M = 8, SD = 1.78) (p = <0.01)	**EA (M = 12, SD = 2.05) LA (M = 8, SD = 1.30) (p = <.01)**
EA (M = 13, SD = 2.50) MA (M = 11, SD = 2.15) (p = <0.01)	**EA (M = 12, SD = 2.05) MA (M = 10, SD = 2.09) (p = 0.03)**
Neutral Items **M = Means, SD = Standard Deviations**	**Neutral Items** **M = Means, SD = Standard Deviations**
EA (M = 7, SD = 3.61) LA (M = 4, SD = 1.27) (p = <0.01)	**MA (M = 5, SD = 0.92) LA (M = 3, SD = 1.11) (p = p<.01)**
EA (M = 13, SD = 2.50) MA (M = 5, SD = 1.30) (p = <.01)	**MA (M = 5, SD = 0.92) EA (M = 3, SD = 1.11) (p = <.01)**

The main effect of age on the standard and modified remember/know experiments is supported by the interaction effect between the emotional valence conditions and the age of the participant, F (4, 3.83) = 5.55, p = <.01. Contrasts on the interaction revealed that there was a significant interactions when comparing the participants in the Early, Middle and Late Adulthood correct remember scores for the positive valence (neutral arousal) words to the negative valence (neutral arousal) words, F (1, 1.82) = 3.45, p = 0.02 and to the neutral valence (neutral arousal) words, F (1, 1.82) = 2.99, p = 0.01 and comparing negative valence (neutral arousal) words to F (1, 1.82) = 3.62, p = <.01

4.3.2. Examining the Visual and Auditory Correct Know responses relating to hypothesis II using a Three Way Mixed ANOVA

Hypothesis II- There will be a significant difference in the number of correct know words for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood).

4.3.2.1. Visual Standard and Modified Correct Know Responses

There was significant main effect of age on the correct know responses within the visual standard and modified remember/know experiments, F (2, 1.50) = 20.24, p = <.01. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that the correct number of know responses for the positive, negative and neutral items within the standard remember/know experiment was significantly higher in the Late Adulthood group than the Early and Middle Adulthood groups. Post-hoc analyses using the Scheffé post hoc

criterion for significance indicated that there was a significantly higher number of correct know responses for the positive, negative or neutral items within the modified remember/know experiments for the Early Adulthood group than the Middle or Late Adulthood groups. The results for the Scheffé post hoc criterion for correct know responses within the visual standard and modified remember/know experiment are displayed in Table 18 below

Table 18- Scheffé's post hoc analyses on the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) group's positive, negative and neutral Correct Know Responses for the Visual Standard and Modified Remember/Know Experiments

Comparison Between VISUAL STANDARD Remember/Know Age Groups using Scheffé Post Hoc Criterion	**Comparison Between VISUAL MODIFIED Remember/Know Age Groups using Scheffé Post Hoc Criterion**
Positive Items **M = Means, SD = Standard Deviations**	**Positive Items** **M = Means, SD = Standard Deviations**
LA (M = 8, SD = 1.75) EA (M =4, SD = 1.55) (p = <.01)	**MA (M = 8, SD = 2.33) EA (M = 6, SD = 1.53) (p = <.01)**
LA (M = 8, SD = 1.75) MA (M =4, SD = 1.90) (p = <.01)	**MA (M = 8, SD = 2.33) LA (M =6, SD = 2.70) (p = <.01)**
Negative Items **M = Means, SD = Standard Deviations**	**Negative Items** **M = Means, SD = Standard Deviations**
LA (M = 6, SD = 1.16) EA (M = 4, SD = 1.81) (p = <.01)	**LA (M = 8, SD = 1.29) EA (M = 4, SD = 1.49) (p = <.01)**
LA (M = 6, SD = 1.16) MA (M = 5, SD = 3.28) (p = <.01)	**LA (M = 8, SD = 1.29) MA (M = 6, SD = 1.46) (p = <.01)**
Neutral Items **M = Means, SD = Standard Deviations**	**Neutral Items** **M = Means, SD = Standard Deviations**
EA (M = 9, SD = 3.46) MA (M = 9, SD = 3.01) (p = <.01)	**EA (M = 10, SD = 2.06) MA (M = 10, SD = 2.83) (p = 0.02)**
EA (M = 9, SD = 3.46) LA (M = 7, SD = 1.69) (p = 0.02)	**EA (M = 10, SD = 2.06) LA (M = 9, SD = 1.06) (p = 0.04)**

However, the main effect of age on the standard and modified experiments are not supported by an interaction effect between the emotional valence conditions and the age of the participant, $F (2, 35.82) = 2.10$, $p = 0.352$.

4.3.2.2. Auditory Standard and Modified Correct Know Responses

There was significant main effect of age on the correct know responses within the auditory standard and modified remember/know experiments, $F (2, 255.17) = 52.41$, $p = <.01$. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that the correct number of know responses for the negative items within the standard remember/know experiment was significantly higher in the Middle and Late Adulthood groups than the Early Adulthood group. There was also a significantly higher number of correct know responses for the neutral items in the Early Adulthood group than the Middle and Late Adulthood groups. However, there was no significant difference in the number of correct know responses between the three age groups for the positive items. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that there was no significant difference between the correct number of know responses for the positive, negative or neutral items within the modified remember/know experiment across the three age groups.

The results for the Scheffé post hoc criterion for correct know responses within the visual standard and modified remember/know experiment are displayed in Table 19 below;

Table 19 - Scheffé's post hoc analyses on the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) group's positive, negative and neutral Correct Know responses for the Auditory Standard and Modified Remember/Know Experiments

Comparison Between AUDITORY STANDARD Remember/Know Age Groups using Scheffé Post Hoc Criterion	**Comparison Between AUDITORY MODIFIED Remember/Know Age Groups using Scheffé Post Hoc Criterion**
Positive Items **M = Means, SD = Standard Deviations**	**Positive Items** **M = Means, SD = Standard Deviations**
EA (M = 6, SD = 2.97) MA (M =6, SD = 1.24) (p = 0.940)	**EA (M = 6, SD = 2.97) MA (M =6, SD = 1.24) (p = 0.410)**
EA (M = 6, SD = 2.97) LA (M =5, SD = 1.22) (p = 0.871)	**EA (M = 6, SD = 2.97) LA (M =5, SD = 1.22) (p = 0.410)**
Negative Items **M = Means, SD = Standard Deviations**	**Negative Items** **M = Means, SD = Standard Deviations**
LA (M = 6, SD = 1.10) MA (M = 6, SD = 3.28) (p = <.01)	**LA (M = 6, SD = 1.10) MA (M = 6, SD = 3.28) (p = 0.502)**
LA (M = 6, SD = 1.10) EA (M = 4, SD = 1.86) (p = <.01)	**LA (M = 6, SD = 1.10) EA (M = 4, SD = 1.86) (p = 0.906)**
Neutral Items **M = Means, SD = Standard Deviations**	**Neutral Items** **M = Means, SD = Standard Deviations**
EA (M = 9, SD = 3.53) MA (M = 6, SD = 1.35) (p = <.01)	**EA (M = 9, SD = 3.53) MA (M = 6, SD = 1.35) (p = 0.084)**
EA (M = 9, SD = 3.53) LA (M = 7, SD = 1.60) (p = <.01)	**EA (M = 9, SD = 3.53) LA (M = 7, SD = 1.60) (p = 0.943)**

However, this main effect is not supported by the interaction effect between the emotional valence conditions and the age of the participant, $F(4, 3.46) = 7.01$, $p = 0.124$.

4.3.3. Examining the Visual and Auditory Correct Remember Responses relating to hypothesis III using Mann-Whitney U Tests

Hypothesis III- There will be more correct remember responses for the visual standard and modified experiments in contrast to the auditory standard and modified remember/know experiments for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood).

The results of the Mann-Whitney U tests revealed that there were no significant differences between the correct positive, negative and neutral remember responses for the visual and auditory standard experiments and the visual and auditory modified experiments. The results for the correct remember responses between the visual and auditory experiments are reported in Table 20 below

Table 20- The Mann-Whitey U Test Scores Comparing Correct Remember Responses between the Visual and Auditory Standard and Modified Remember/Know Experiments

Visual and Auditory Standard Remember/Know Comparisons	**Mann-Whitney U Test Results**		
	U	**z**	**p**
Comparisons Between Valence Items			
Positive Valence	**180.00**	**-1.672**	**0.094**
Negative Valence	**245.00**	**-0.183**	**0.855**
Neutral Valence	**247.50**	**-0.216**	**0.900**
Visual and Auditory Modified Remember/Know Comparisons	**Mann-Whitney U Test Results**		
	U	**z**	**p**
Comparisons Between Valence Items			
Positive Valence	**187.00**	**-1.538**	**0.124**
Negative Valence	**200.50**	**-1.201**	**0.230**
Neutral Valence	**234.00**	**-0.437**	**0.662**

4.3.4. *Examining the Visual and Auditory Correct Know Responses relating to Hypothesis IV using Mann-Whitney U Tests*

Hypothesis IV- There will be more correct know responses for the visual and auditory modified experiments in comparison to the visual and auditory standard experiments for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood).

The results of the Mann-Whitney U tests revealed that there were no significant differences between the correct positive, negative and neutral know responses for the visual and standard experiments and the visual and auditory modified

experiments. The results for the correct know responses between the visual and auditory experiments are reported in Table 21 below;

Table 21- The Mann-Whitey U Test Scores Comparing Correct KnowResponses between the Visual and Auditory Standard and Modified Remember/Know Experiments

Visual and Auditory Standard Remember/Know Comparisons	**Mann-Whitney U Test Results**		
	U	**z**	**p**
Comparisons Between Valence Items			
Positive Valence	**226.00**	**-0.619**	**0.536**
Negative Valence	**237.00**	**-0.370**	**0.711**
Neutral Valence	**246.00**	**-0.161**	**0.872**
Visual and Auditory Modified Remember/Know Comparisons	**Mann-Whitney U Test Results**		
	U	**z**	**p**
Comparisons Between Valence Items			
Positive Valence	**217.50**	**-0.839**	**0.402**
Negative Valence	**245.50**	**-0.716**	**0.860**
Neutral Valence	**236.00**	**-0.397**	**0.692**

4.3.5. Examining the Visual and Auditory Response Bias Scores relating to Hypothesis V using a three way Mixed ANOVA

Hypothesis V- There will be a significant difference in liberal and conservative response bias for each of the emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood).

4.3.5.1. Visual Standard and Modified Response Bias

The three-way Mixed ANOVA revealed that there was no significant effect of age on the response bias scores within the visual standard and modified remember/know experiments, indicating that the response bias scores for the positive, negative and neutral items were generally the same across the three age groups, $F(2, 1.14) = 0.23$, $p = 0.670$.

4.3.5.2. Auditory Standard and Modified Response Bias

The three-way Mixed ANOVA revealed that there was no significant effect of age on the response bias scores within the auditory standard and modified remember/know experiments, indicating that the response bias scores for the positive, negative and neutral items were generally the same across the three age groups, $F(2, 2.28) = 0.54$, $p = 0.590$

5. **Visual and Auditory (Standard and Modified) Self-Relevance Questionnaire Methodology**

5.1. Participants

The participants that completed the visual or auditory remember/know experiments were again selected to participate in the visual or auditory self-relevance questionnaires, whilst remaining in their respected age groups (i.e. the 48 participants that completed the visual and the 48 participants that completed the auditory remember/know experiments completed the appropriate self-relevance questionnaires). The purpose of using the same participants was to find out whether the self-relevance questionnaire scores where reflective of each individual's recognition memory performance scores for the emotional

valence (neutral arousal) items within the visual or auditory remember/know experiments. For instance, are the higher negative correct remember scores for the Early Adulthood group in contrast to the Middle and Late Adulthood groups within the visual and auditory remember/know experiments reflected in the self-relevance scores?.

5.2. Self-Relevance Questionnaires

The standard and modified questionnaires present the positive, negative and neutral valence (neutral arousal) words from the study phases of the standard and modified remember/know experiments in list form. At the top of the questionnaire, instructions and a 5-point rating scale are provided, which primarily instructs the participants from the three age groups to look at each word individually and give a score between 1 to 5 (1= very slightly or not at all, 2= a little, 3= moderately, 4= quite a bit, 5= extremely) to reflect the relevance a word has on the individual's everyday existence. For instance, if an individual works in a clothes factory, then the word 'fabric' could achieve a score of 4 or 5. As the words presented in the study phases of the visual standard and modified experiments are the same as the words presented in the study phases of the auditory standard and modified remember/know experiments, only two self-relevance questionnaires were required (i.e. a standard and modified self-relevance questionnaire). The self-relevance questionnaires created for the visual and auditory standard and modified remember/know study phase words are shown in Appendix 11 (standard self-relevance questionnaire) and Appendix 12 (modified self-relevance questionnaire).

5.3. Procedure

Immediately after the participants completed the standard or modified remember/know experiments, the completed either the standard or modified self-relevance questionnaires. Once the self-questionnaires were completed by each participant, the scores for the positive, negative and neutral valence (neutral arousal) words were added together, so that a self-relevance score could be observed for the positive, negative and neutral study phase words. In effect, each participant within the three age groups will have three separate self-relevance scores.

5.4. Statistical Analysis

5.4.1. Measuring the Impact of the Visual and Auditory (Standard and Modified) Self-Relevance Questionnaire Order Effects

This analysis focused on examining the standard-modified and modified-standard orders of experiments that a participant could have completed the self-relevance questionnaires in.

The results of this analysis were analysed using IBM SPSS 20. A *Shapiro-Wilks* test of normality revealed that not all the emotional valence (neutral arousal) words were normally distributed. Therefore, non-parametric *Mann-Whitney U* tests were performed on the visual and auditory emotional valence (neutral arousal) words for the three adult age groups (i.e. Early, Middle and Late Adulthood).

5.4.2. Visual and Auditory (Standard and Modified) Self-Relevance Questionnaires

The results for the visual standard and modified self-relevance questionnaires were analysed using IBM SPSS 20. From the Shapiro-Wilks test of normality, not all the emotional valence (neutral arousal) words were normally distributed. Therefore, three-way mixed ANOVA's were performed to examine the recognition emotional valence (neutral arousal) words within the visual and auditory standard and modified self-relevance questionnaires (relating to hypothesis VI).

6. Results for the Visual and Auditory (Standard and Modified) Self-Preference Questionnaires

6.1. Means and Standard Deviations for the Visual and Auditory Self-Relevance Questionnaires

6.1.1. Visual Standard and Modified Self-Relevance Scores

Table 22 illustrates the means and standard deviations for the three adult age groups self-relevance scores, with regards to the visual presentation of the emotional valence (neutral arousal) items in the standard and modified remember/know study phases.

Table 22- The Means and Standard Deviations (SD) for the Early (EA), Middle (MA) and Late Adulthood (LA) groups Visual Standard and Modified Positive, Negative and Neutral Self-Relevance scores

Visual Standard Self-Relevance Scores	**EA**	**MA**	**LA**	**Visual Modified Self-Relevance Scores**	**EA**	**MA**	**LA**
Standard Items	**Means (SD)**			**Modified Items**	**Means (SD)**		
Positive	**81(7.12)**	**79(8.80)**	**76(11.44)**	**Positive**	**81(7.25)**	**79(9.61)**	**76(11.94)**
Negative	**50(9.82)**	**44(8.28)**	**43(8.14)**	**Negative**	**50(10.96)**	**44(7.50)**	**43(7.32)**
Neutral	**69(7.14)**	**68(7.63)**	**64(9.26)**	**Neutral**	**79(7.05)**	**76(9.92)**	**74(11.69)**

The following summary describes the pattern of results from the means expressed in table 22 for the visual standard and modified self-relevance scores.

6.1.1.1. *A Summary of the Visual Standard and Modified Self-Relevance Scores*

For both the standard and modified self-relevance questionnaires, table 22 indicates that the Early Adulthood group provided the highest relevance scores, whereas the Late Adulthood group provided the lowest relevance scores for the positive, negative and neutral items. The positive and negative relevance scores for the standard and modified questionnaires are interestingly the same and the standard deviation figures are similar. For instance, the Late Adulthood's positive standard deviation figure is the largest standard deviation figure in comparison to the Early and Middle Adulthood group's positive standard deviations figures. However, the standard deviation figures for all the self-relevance scores are reasonably large (e.g. the standard deviation figures

for the Late Adulthood group's positive self-relevance scores in the standard and modified questionnaires are above 11), which suggests that there is a large dispersion in the self-relevance scores from the mean scores provided in table 22.

6.1.2. Auditory Standard and Modified Self-Relevance Scores

Table 23- The Means and Standard Deviations (SD) for the Early (EA), Middle (MA) and Late Adulthood (LA) groups Auditory Standard and Modified Positive, Negative and Neutral Self-Relevance scores

Auditory Standard Self-Relevance Scores	**EA**	**MA**	**LA**	**Auditory Modified Self-Relevance Scores**	**EA**	**MA**	**LA**
Standard Items	**Means (SD)**			**Modified Items**	**Means (SD)**		
Positive	**83(11.21)**	**76(13.05)**	**72(15.45)**	**Positive**	**86(11.31)**	**75(10.80)**	**73(15.23)**
Negative	**54(12.21)**	**50(13.95)**	**49(15.01)**	**Negative**	**68(12.53)**	**63(13.99)**	**51(15.96)**
Neutral	**66(14.22)**	**58(15.06)**	**49(15.22)**	**Neutral**	**66(19.26)**	**64(17.55)**	**63(12.54)**

Table 23 illustrates the means and standard deviations for the three adult age groups self-relevance scores, with regards to the auditory presentation of the emotional valence (neutral arousal) items in the standard and modified remember/know study phases.

The following summary describes the pattern of results from the means expressed in table 23 for the auditory standard and modified self-relevance scores.

6.1.2.1. A Summary of the Auditory Standard and Modified Self-Relevance Scores

Table 23 indicates that similarly to the visual self-relevance scores, the Early Adulthood groups produce the highest auditory self-relevance scores for the positive, negative and neutral items, whereas the Late Adulthood group produce the lowest. However, there is a substantial variation in the mean self-relevance scores between the standard and modified questionnaires, particularly for the negative self-relevance scores. For instance, the Early Adulthood group produce the highest negative items scores in both questionnaires, yet the participant's provide the negative items in the modified questionnaire with a mean score of 68 and the negative items in the standard questionnaire with a mean score of 54 (i.e. a mean difference of 14). These mean differences between the self-relevance questionnaire scores are supported by the corresponding standard deviations, which are similar to one another (i.e. the negative self-relevance scores for the Early Adulthood group are 12.21 for the standard questionnaire and 12.53 for the modified questionnaire).

6.2. A Statistical Analysis for the Impact of Order Effects on the Visual and Auditory Self-Relevance Questionnaires

The Shapiro-Wilks test of normality indicated that there were non-normal distributions for the visual and auditory self-relevance questionnaire scores that coincided with the standard-modified and modified-standard experimental sequences. Subsequently, Mann-Whitney U tests were performed on the visual

and auditory self-relevance scores for the three emotional valence (neutral arousal) conditions.

The results of the Mann-Whitney U tests revealed that there were no significant differences between the standard-modified and modified-standard experimental sequences for the visual and auditory self-relevance questionnaires. The results for the Mann-Whitney U tests are reported for each of the visual and auditory recognition memory performance measures in table 24 below.

Table 24- The Mann-Whitey U Test Scores for the Standard-Modified and Modified-Standard Experimental Sequences relating to the Visual and Auditory Self-Relevance Questionnaires

Visual Standard and Modified Self-Preference Questionnaire Scores	**Mann-Whitney U Test Results**		
	U	**z**	**p**
Study Phase Target Items			
Positive Valence	**2429.50**	**-0.650**	**0.52**
Negative Valence	**2572.00**	**-0.080**	**0.93**
Neutral Valence	**2262.00**	**-1.320**	**0.19**
Auditory Standard and Modified Self-Preference Questionnaire Scores	**Mann-Whitney U Test Results**		
	U	**z**	**p**
Study Phase Target Items			
Positive Valence	**2333.00**	**-1.036**	**0.30**
Negative Valence	**2472.50**	**-0.478**	**0.63**
Neutral Valence	**2328.50**	**-1.054**	**0.29**

6.3. Using Three Way Mixed ANOVA's to Examine Hypothesis VI of the Present Study

6.3.1. Visual Standard and Modified Self-Preference Questionnaires

A three-way Mixed ANOVA revealed that there was a significant main effect of age on the self-relevance scores within the visual standard and modified self-relevance questionnaires, $F(2, 36) = 308.57$, $p = <.01$. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that the self-relevance scores for the positive, negative and neutral items within the standard and modified self-relevance questionnaires was significantly higher in the Early Adulthood group than the Middle and Late Adulthood groups.

The results for the Scheffé post hoc criterion for the self-relevance scores within the visual standard and modified self-relevance questionnaires are displayed in Table 25 below;

Table 25 - Scheffé's post hoc analyses on the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) group's positive, negative and neutral Self-Relevance Scores for the Visual Standard and Modified Remember/Know Experiments

Comparison Between VISUAL STANDARD Remember/Know Age Groups using Scheffé Post Hoc Criterion	**Comparison Between VISUAL MODIFIED Remember/Know Age Groups using Scheffé Post Hoc Criterion**
Positive Items **M = Means, SD = Standard Deviations**	**Positive Items** **M = Means, SD = Standard Deviations**
EA (M = 87, SD = 7.12) MA (M =79, SD = 8.80) (p = <.01)	**EA (M = 81, SD = 7.25) MA (M =79, SD = 9.61) (p = <.01)**
EA (M = 87, SD = 7.12) LA (M =76, SD = 11.44) (p = <.01)	**EA (M = 81, SD = 7.25) LA (M =76, SD = 11.94) (p = <.01)**
Negative Items **M = Means, SD = Standard Deviations**	**Negative Items** **M = Means, SD = Standard Deviations**
EA (M = 50, SD = 9.82) MA (M = 44, SD = 8.28) (p = <.01)	**EA (M = 50, SD = 10.96) MA (M = 44, SD = 7.50) (p = <.01)**
EA (M = 50, SD = 9.82) LA (M = 43, SD = 8.14) (p = <.01)	**EA (M = 50, SD = 10.96) LA (M = 43, SD = 7.32) (p = <.01)**
Neutral Items **M = Means, SD = Standard Deviations**	**Neutral Items** **M = Means, SD = Standard Deviations**
EA (M = 69, SD = 7.14) MA (M = 68, SD = 7.63) (p = <.01)	**EA (M = 79, SD = 7.05) MA (M = 76, SD = 9.92) (p = <.01)**
EA (M = 69, SD = 7.14) LA (M = 64, SD = 9.26) (p = <.01)	**EA (M = 79, SD = 7.05) LA (M = 74, SD = 11.69) (p = <.01)**

This main effect is supported by a significant interaction effect between the emotional valence conditions and the age of the participant, F (4, 72) = 43.26, p = <.01. Contrasts on the interaction revealed that there was a significant

interactions when comparing the participants in the Early, Middle and Late Adulthood correct remember scores for the positive valence (neutral arousal) words to the negative valence (neutral arousal) words, $F (1, 18) = 24.16$, $p = 0.04$ and to the neutral valence (neutral arousal) words, $F (1, 18) = 14.23$, $p = 0.03$ and comparing negative valence (neutral arousal) words to neutral valence (neutral arousal) words, $F (1, 18) = 22.13$, $p = <.01$.

6.3.2. Auditory Standard and Modified Self-Preference Questionnaires

There was significant main effect of emotional valence (neutral arousal) words) on the self-relevance scores within the auditory standard and modified self-relevance questionnaires, $F (2, 36) = 302.48$, $p = <.01$. Post-hoc analyses using the Scheffé post hoc criterion for significance indicated that the self-relevance scores for the positive, negative and neutral items within the standard self-relevance questionnaire was significantly higher in the Early Adulthood group than the Middle and Late Adulthood groups. Post-hoc analyses using the Scheffé post hoc criterion for significance also indicated that the self-relevance scores for the positive, negative and neutral items within the modified self-relevance questionnaire was significantly higher in the Early Adulthood group than the Middle and Late Adulthood groups.

The results for the Scheffé post hoc criterion for the self-relevance scores within the auditory standard and modified self-relevance questionnaires are displayed in Table 26 below;

Table 26 - Scheffé's post hoc analyses on the Early Adulthood (EA), Middle Adulthood (MA) and Late Adulthood (LA) group's positive, negative and neutral Self-Relevance Scores for the Auditory Standard and Modified Remember/Know Experiments

Comparison Between AUDITORY STANDARD Remember/Know Age Groups using Scheffé Post Hoc Criterion	**Comparison Between AUDITORY MODIFIED Remember/Know Age Groups using Scheffé Post Hoc Criterion**
Positive Items **M = Means, SD = Standard Deviations**	**Positive Items** **M = Means, SD = Standard Deviations**
EA (M = 83, SD = 11.21) MA (M =76, SD = 13.05) (p = <.01)	**EA (M = 86, SD = 11.31) MA (M =75, SD = 10.80) (p = 0.02)**
EA (M = 83, SD = 11.21) LA (M = 72, SD = 15.45) (p = <.01)	**EA (M = 86, SD = 11.31) LA (M = 73, SD = 15.23) (p = 0.02)**
Negative Items **M = Means, SD = Standard Deviations**	**Negative Items** **M = Means, SD = Standard Deviations**
EA (M = 54, SD = 12.21) MA (M = 50, SD = 13.95) (p = 0.04)	**EA (M = 68, SD = 12.53) MA (M = 63, SD = 13.99) (p = <.01)**
EA (M = 54, SD = 12.21) LA (M = 49, SD = 15.01) (p = <.01)	**EA (M = 68, SD = 12.53) LA (M = 51, SD = 15.96) (p = <.01)**
Neutral Items **M = Means, SD = Standard Deviations**	**Neutral Items** **M = Means, SD = Standard Deviations**
EA (M = 66, SD = 14.22) MA (M = 58, SD = 15.06) (p = <.01)	**EA (M = 66, SD = 19.26) MA (M = 64, SD = 17.55) (p = <.01)**
EA (M = 66, SD = 14.22) LA (M = 49, SD = 15.22) (p = <.01)	**EA (M = 66, SD = 19.26) LA (M = 63, SD = 12.54) (p = <.01)**

This main effect is supported a significant interaction effect between the emotional valence conditions and the age of the participant, F (4, 72) = 56.40, p = 0.02. Contrasts on the interaction revealed that there was a significant

interactions when comparing the participants in the Early, Middle and Late Adulthood correct remember scores for the positive valence (neutral arousal) words to the negative valence (neutral arousal) words, $F(1, 18) = 17.26$, $p = <.01$ and to the neutral valence (neutral arousal) words, $F(1, 18) = 20.03$, $p = 0.02$ and comparing negative valence (neutral arousal) words to neutral valence (neutral arousal) words, $F(1, 18) = 15.22$, $p = <.01$.

7. Discussion

7.1. Understanding the Impact Emotional Valence (Neutral Arousal) Items have on the Visual and Auditory Recognition Memory Performance within Adult Aging

After examining the previous research that has focused on the influence of visually presented emotions on aging and remembering, there appeared to be similarly conflicting findings between between perspectives (i.e. remember/know procedure, socioemotional selectivity theory, response bias) which fundamentally meant that it is currently not understood whether differences in aging and remembering exist because of cognitive decline (Davidson & Glisky, 2002; Denburg et al., 2003; Kensinger et al., 2002; Old & Naveh-Benjamin, 2008; Otani et al, 2007) or because younger and older adults self-regulate emotions differently (Charles et al., 2003). In addition, it has been argued that the remember/know procedure (Gardiner., 1988; Tulving, 1985) underestimates know responses, which suggests that research that has studied remembering in younger and older adults could potentially be unreliable when using the remember/know procedure (Jacoby et al., 1997). However, to the author's knowledge, previous recognition memory research has not made an

attempt to; integrate a measure of self-relevance (relating to the socioemotional selectivity theory) and response bias with the remember/know experiment, it has not compared the results of standard remember/know procedure (Gardiner., 1988; Tulving, 1985) with the results of another remember/know procedure, nor has it directly compared visual and auditory remember/know performance across the three adult age groups; Early, Middle and Late Adulthood. Consequently, the primary aim of the present study has been to investigate the impact emotional valence (positive, negative, neutral) with neutral arousal items has on the visual and auditory recognition memory performance (remember and know responses), response bias and self-relevance scores of participants that represent the three adult age groups; Early, Middle and Late Adulthood.

To investigate the impact of emotion valence (neutral arousal) on aging and recognition memory, six hypotheses were tested within the present study using eight experiments. For four of the eight experiments, the results of the visual and auditory standard remember/know (Gardiner., 1988; Tulving, 1985) and the modified remember/know (Sheridan and Reingold, 2011) procedures and response bias ‘C’ scores (Ingham, 1970) were used to answer hypotheses I to V. For the other four of the eight experiments, the results of the visual and auditory standard and modified self-relevance questionnaires based on the assumption of the socioemotional selectivity theory perspective (Charles et al., 2003) were used to answer hypothesis VI.

7.1.1. Hypothesis I: the Visual Standard and Modified Correct Remember Responses

Hypothesis I stated that ‘there will be a significant difference in the number of correct remember words for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)’. Based on the results of the visual standard and modified remember/know experiments, hypothesis I could be accepted on the basis that the three-way Mixed ANOVA’s for the visual experiments demonstrated that there was a main effect of the independent variable of age on the two dependent variables of remember/know procedure; standard and modified.

A Scheffé post-hoc analysis for significance revealed that the participants in the Early Adulthood group had significantly higher numbers of correct remember responses for the positive, negative and neutral valence (neutral arousal) items for both the standard and modified remember/know experiments. The main effects for the visual standard and modified remember/know experiments were supported by an interaction effect between the visual emotional valence (neutral arousal) conditions and the age of the participant, with contrasts revealing that there was a significant interaction between the three age groups correct remember responses for the positive, negative and neutral valence (neutral arousal) conditions. The visual findings relating to hypothesis I are important to the debate on the impact of emotional items on aging and remembering between the dual-process recognition memory assumption and the socioemotional selectivity theory, as the findings represent the key component of remembering in the form of correct remember responses.

Essentially, the findings of hypothesis I relating to the visual sensory modality suggest that younger adults (Early Adulthood) produce a significantly higher number of correct remember responses than older adults (Late Adulthood), but older adults demonstrate that they have a higher number of correct remember responses for the positive and negative valence (neutral arousal) items than the neutral valence (neutral arousal) items. This pattern of results is demonstrated in both the visual standard and modified remember/know experiments. From these results, these findings support the claim that although older adults show a decline in memory in comparison to younger adults, both younger and older adults remember positive and negative items more than neutral information (Davidson & Glisky, 2002; Denburg et al., 2003; Kensinger et al., 2002; Mather & Sutherland, 2009; May et al., 2005; Old & Naveh-Benjamin, 2008; Otani et al, 2007). In addition, the inclusion of a Middle Adulthood group in the present study, which reveals a significant decrease in correct remember responses in comparison to the younger adults but a significant increase in correct remember responses than older adults, firstly demonstrates that the process of remembering is similar to other memory processes, as it is susceptible to the cognitive decline that is associated with healthy aging (e.g. Salthouse, 2004; Shapiro & Penrod, 1986). Secondly, it demonstrates a clearer pattern of results to suggest that remembering changes in conjunction with the transition of aging (i.e. remembering continues to decrease as an adult continues to age), as opposed to obtaining results that intend on showing a continual pattern between aging and remembering by comparing only younger and older adults (Kensinger, 2011). Consequently, the findings relating to hypothesis I can be

interpreted as evidence for remembering being a process determined by cognitive decline, with individuals not having an ability to self-regulate emotional items even as they age, as proposed by the socioemotional selectivity theory (Carstensen, 1993, 1995, 2005; Carstensen et al., 2003; Carstensen et al., 1999).

However, the findings of hypothesis I could still be interpreted as evidence of remembering being a self-regulating process, if the argument by Carsten et al (2003) is taken into account, which fundamentally argues that if remembering was a process of cognitive decline, then there should not be an increase in the correct remember responses for either the positive or negative items. Instead, if the findings of hypothesis I were to reflect cognitive decline, then there theoretically should be no significant difference between positive or negative remember responses and predictably this should extend to the remembering of neutral items, as the notion of cognitive decline implies that overall remembering will be effected an individual ages (i.e. the capacity of remembering will be less effective in retaining any type of emotional valence (neutral arousal) item). Yet, the results of the visual standard and modified remember/know experiments display that the remembering of positive and negative items, even though declining, is discriminate throughout aging. An ability to discriminate in favour of positive or negative items (i.e. having a conscious and unconscious choice to select positive and negative items) is parallel to the notion of the socioemotional selectivity theory. As a result, the findings of hypothesis I could effectively be interpreted as supporting the

socioemotional selectivity theory as well as the theory relating to cognitive decline.

Nevertheless, the correct remember responses for the visual standard and modified remember/know experiments can also be interpreted as providing conflicting evidence with regards to the notion of a negativity and positivity effect between younger and older adults, which is proposed in some of the recognition memory and socioemotional selectivity literature (Carstensen et al., 2000; Charles et al., 2001; Wood & Kisley, 2006; Kensinger, 2008; 2009; Kensinger & Leclerc, 2009; Mather & Sutherland, 2009 Murphy & Isaacowitz, 2008; Waring & Kensinger., 2009). Notably, the results of the standard remember/know experiment denotes that younger adults experience a positivity effect (i.e. a higher remembering for positive items) (Kensinger, 2008; 2009; Murphy & Isaacowitz, 2008; Waring & Kensinger., 2009) and not a negativity effect (i.e. a higher remembering for negative items) (Wood & Kisley, 2006; Kensinger & Leclerc, 2009; Mather & Sutherland, 2009). Conversely, the results of the modified remember/know experiment indicates that younger adults experience a negativity effect and not a positivity effect. Furthermore, the findings from the standard remember/know experiment appear to reject Kensinger's (2008) result to suggest that younger adults will have an increased remembering for negative valence (neutral arousal), but the findings also appear to support the result that older adults will have an increased remembering for positive valence (neutral arousal) items. In contrast, the results from the modified remember/know experiment would support Kensinger's (2008) result as it showed younger adults to remember more negative valence

(neutral arousal) items and older adults to remember more positive valence (neutral arousal) items. In general, the correct remember responses for the visual standard and modified remember/know experiments are conflicting and can be construed as being supportive of different notions into the impact of emotion on aging and remembering, which is solely dependent upon whether the results of the standard or modified experiments are interpreted together (evidence of cognitive decline and self-emotional regulation) or they are considered as individually (evidence of a positivity or negativity effect between younger and older adults).

7.1.2. Hypothesis I: Auditory Standard and Modified Correct Remember Responses

Based on the results of the auditory standard and modified remember/know experiments, hypothesis I could be accepted on the basis that the three-way Mixed ANOVA's for the auditory experiments demonstrated that there was a main effect of the independent variable of age on the two dependent variables of remember/know procedure; standard and modified. A Scheffé post-hoc analysis for significance revealed that the participants in the Early Adulthood group had significantly higher numbers of correct remember responses for the positive, negative and neutral valence (neutral arousal) items for the standard remember/know experiments. A Scheffé post-hoc analysis for significance revealed that participants in the Early Adulthood groups had significantly higher correct remember responses for the positive and negative valence (neutral arousal) items, and the participants in the Middle Adulthood group had significantly higher correct remember responses for the neutral valence (neutral

arousal) items for the modified remember/know experiment. The main effects for the auditory standard and modified remember/know experiments were supported by an interaction effect between the auditory emotional valence (neutral arousal) conditions and the age of the participant, contrasts revealing that there was a significant interaction between the three age groups correct remember responses for the positive, negative and neutral valence (neutral arousal) conditions.

When the auditory remember/know results are coupled with the visual remember/know results, the significant main effects and interaction effects can confirm that emotional items measured by the characteristics of valence and arousal, do have an impact on remember responses (e.g. reviewed by Dolan, 2002; Wolf, 2008). Indeed, the auditory findings relating to hypothesis I cannot be directly compared with any previous auditory recognition memory research that has implemented the remember/know procedure. Yet, the findings would still satisfy the previous results that suggest auditory recognition equips individuals to remember specific details of their past encounters similarly to visual recognition memory (Chartrand et al., 2008; Cohen et al., 2009; Cohen et al., 2011; Cycowicz & Friedman, 1999; Drakeford et al., 2006; Gottlieb et al., 2010; Nadine, 2010). Nevertheless, there is a significant pattern of results within the auditory findings that causes concern for the reliably of the standard remember/know experiment.

The concern is for the result that indicates that participants in the Late Adulthood groups have significantly higher correct remember responses for the positive valence (neutral arousal) items than the participants in the Middle

Adulthood groups within the standard remember/know experiment. Basically, this result indicates that individual's will have a decrease in remembering from Early to Middle Adulthood, but will have an improvement in remember in Late Adulthood. This pattern of results could be as suggested by Jacoby et al (1997) 'an artifact of the remember/know procedure', that is produced by the underestimation of know responses when using the remember/know procedure. Undeniably, Jacoby et al (1997) used the term to explain Parkin and Walter's (1992) result, which showed that older adults had a higher number of know responses than younger adults to compensate for their decrease in remember responses. In addition, Jacoby et al (1997) also suggested that if a participant can only choose between remember and know, and remember responses are encouraged even when there is a possibility that the individual has experienced a joint remember/know response, then any underestimation that know responses receive would have to be compensated by an overestimation of remember responses. For example, if the 20 positive target items from the study phase within the present standard remember/know experiment are distributed between remember and know, and the know responses are underestimated to 5 responses, then the remember responses would have to be overestimated to 15 responses, in order to account for the 20 positive target items. Therefore, the result of the Late Adulthood group achieving significantly more correct remember responses for the positive valence (neutral arousal items) than the Middle Adulthood group could support the claim that the standard remember/know procedure is unreliable in measuring recognition memory (Jacoby et al, 1997).

7.1.3. Hypothesis II: The Visual and Auditory (Standard and Modified) Know Responses

Hypothesis II stated that ‘there will be a significant difference in the number of correct Know words for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)’. Based on the results of the visual and auditory standard and modified remember/know experiments, there are conflicting arguments as whether hypothesis II could be retained or rejected. Evidently, the three-way Mixed ANOVA’s for the visual and auditory experiments demonstrated that there was a main effect of the independent variable of age on the two dependent variables of remember/know procedure; standard and modified. Yet, there were no significant interaction effects between the emotional valence conditions and the age of the participants for the visual and auditory correct know responses.

The argument for accepting this pattern of results for hypothesis II would be that a main effect without an interaction effect simply indicates that the independent variable of age has a significant overall effect on the know responses, and an interaction effect would have just indicated that age and the emotional valence (neutral arousal) items when considered together would have had a significant overall effect on know responses (e.g. Rosenthal et al., 2000). The argument for rejecting significant main effects and non significant interactions would be that without a significant interaction, there is an issue of internal validity because significant main effects of age on know responses may have occurred for several reasons such as response biases between different age groups (e.g.

Field, 2009). Therefore, the way in which the results of the three-way Mixed ANOVA's are interpreted could mean that hypothesis II could be retained or rejected for both visual and auditory standard and modified experiments.

However, on the basis of the Scheffé post-hoc analyses for significance, hypothesis II should arguably be rejected for both the visual and auditory standard and modified remember/know experiments. Undeniably, the Scheffé post-hoc analyses for significance revealed that the visual and auditory standard experiments showed there were significant differences between the age groups. For instance, in the standard visual remember/know experiment, the Late Adulthood group had significantly higher correct know responses for the positive and negative valence (neutral arousal) items than the Early and Middle Adulthood groups. Nevertheless, the significant differences vary between the visual and auditory standard experiments, to the extent that older adult have significantly more correct responses for the positive and negative valence (neutral arousal) items in the visual remember/ know experiment, but not in the auditory remember/know experiment. The Scheffé post-hoc analyses for significance revealed no significant differences between the visual and auditory modified remember/know experiments, meaning that hypothesis II would statistically be rejected.

Firstly, the pattern of results for hypothesis II for the visual and auditory standard remember/know experiments are in accordance with Hirshman and Master's (1997) finding, which suggests that know responses are inconsistently effected by experimental variables (i.e. the emotional valence neutral arousal items in both visual and auditory standard experiment display a different effect

of age on know responses). Secondly, the results support the inclusion of the modified remember/know procedure into the present study, as the prediction that 'regardless of whether or not a result is shown to be significant, the modified remember/know procedure should produce consistent results for know responses' (Sheridan & Reingold, 2011, p. 1340) has been replicated in the visual and auditory modified know findings.

7.1.4. Hypothesis III: Comparing Correct Remember Responses between the Visual and Auditory (Standard and Modified) Remember/Know Experiments

Hypothesis III stated that 'there will be significantly more correct remember responses for the visual standard and modified experiments in contrast to the auditory standard and modified remember/know experiments for each emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)'. Based on comparisons for the correct remember responses between the standard and modified remember/know experiments using the Mann-Whitney U tests, hypothesis III has been rejected as there were no significant results attained between the three age groups for the positive, negative and neutral valence (neutral arousal) items.

The findings relating to hypothesis III disagree with research such as Cohen et al (2009) and Cohen et al (2011) that has found auditory recognition memory to be inferior to visual recognition memory. Furthermore, it disagrees with the review by Mozilic et al (2012) which argued that there is superiority for the

visual sensory modality in comparison to the auditory sensory modality that allows for visual information in an environment to be cognitively processed more efficiently than auditory information.

In consideration of the research to which argued that visual recognition memory should be focused upon due to there being many contradictory findings (Bridgeman et al 1979 Russell, 1980; Hollingworth, 2006; Raymond, 2009), the findings for hypothesis III could argue that the focus of recognition memory research should be divided between visual and auditory sensory modalities. Primarily, the present study's author proposes without a result to show that the visual modality is superior, there is the possibility that extensive research into auditory recognition memory will reveal that auditory recognition memory confers with the complexities found when researching visual recognition memory, if given the chance. With there being no significant differences for the correct remember responses between visual and auditory recognition memory being evident, it must be assumed that visual and auditory recognition memory play an equal role in how an individual remembers everyday encounters, hence both modalities requiring equal research attention.

7.1.5. Hypothesis IV: Comparing the Correct Know Responses for the Visual and Auditory Standard Remember/Know Experiments with the Visual and Auditory Modified Remember/Know Experiments

Hypothesis IV stated that 'there will be more correct know responses for the visual and auditory modified experiments in comparison to the visual and auditory standard experiments for each emotional valence (neutral arousal)

types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)'.Based on comparisons for the correct know responses between the standard visual and auditory remember/know experiments and the modified visual and auditory remember/know experiments using the Mann-Whitney U tests, hypothesis IV has been rejected as there were no significant results attained between the three age groups for the positive, negative and neutral valence (neutral arousal) items.

The findings relating to hypothesis IV when coupled with the findings of hypothesis III provide conspicuous evidence that auditory recognition memory does not significantly differ from visual recognition memory for emotional valence (neutral arousal) items across adult aging. Essentially, hypothesis III and IV demonstrated that auditory recognition memory is at least equal to visual recognition memory when considered from a dual-process perspective (i.e. remember/know), with hypothesis III indicating that there are no significant differences between visual and auditory remember responses and hypothesis IV indicating that there are no significant differences between visual and auditory know responses. In addition, the findings of hypothesis IV support the continual use of the standard remember/know procedure in order to provide a bias free know response measure, without the need for calculations such as Yonelinas and Jacoby's Independence formula to be used (e.g. Naveh-Benjamin & Kilb, 2012; Ozubko et al., 2012). However, the findings of hypothesis IV do not support the inclusion of the visual or auditory modified remember/know procedures (Sheridan & Reingold, 2011) within the present study, as the modified remember/know procedure did not demonstrate an

increase in know performance in comparison to the visual or auditory standard remember/know procedures.

7.1.6. Hypothesis V: Visual and Auditory Response Bias for the Standard and Modified Remember/Know Experiments

Hypothesis V stated that ‘there will be a significant difference in liberal and conservative response bias for each of the emotional valence (neutral arousal) types (positive, negative, neutral) across the age groups (Early, Middle and Late Adulthood)’. Based on the results of the visual and auditory standard and modified response bias scores, Hypothesis IV can be rejected and the null hypothesis accepted, as the three-way Mixed ANOVA revealed that there were no significant differences for the response bias scores between the three age groups. The findings of Hypothesis IV essentially contradicted the notion that adults of various age groups express response bias towards emotional items (Bastin & Van der Linden, 2003; Deason et al., 2012; Dougal & Rotello, 2007; Ferris et al., 1980; Flicker et al., 1990; Grider & Malmberg, 2008; Kapucu et al., 2008; Thapar & Rouder, 2009; Vakil et al., 2003; Windmann & Kutas, 2001).

7.1.7. Hypothesis VI: Visual and Auditory Self-Relevance Scores for the Positive, Negative and Neutral Valence (Neutral Arousal) items

Hypothesis VI stated that ‘there will be a significant difference in the self-relevance scores for each of the emotional valence (neutral arousal) types (positive, negative and neutral) across the age groups (Early, Middle and Late Adulthood)’. Based on the results the three-way Mixed ANOVA’s for the visual and auditory self-relevance questionnaires, there were significant main effects

of age on the two dependent variables of self-relevance questionnaires; standard and modified. A Scheffé post-hoc analysis for significance revealed that the participants in the Early Adulthood group had provided significantly higher self-relevance scores for the positive, negative and neutral valence (neutral arousal) items for both the visual and auditory standard and modified remember/know experiments. The main effects for the visual and auditory standard and modified self relevance questionnaires were supported by an interaction effect between the emotional valence (neutral arousal) conditions and the age of the participant, with contrasts revealing that there was a significant interaction between the three age groups correct remember responses for the positive, negative and neutral valence (neutral arousal) conditions.

From the findings for hypothesis VI, although the Early Adulthood groups produce significantly higher self-relevance scores for the positive, negative and neutral valence (neutral arousal) items presented that were presented in the standard and modified remember/know experiments as suggested by Lawton et al (1992) and Gross et al (1997), older adults appear to maintain a higher remembering for positive items (Charles et al, 2001; Lang & Carstensen, 2002; Mroczek & Kolarz, 1998). Nevertheless, the findings for hypothesis VI do not resemble the research by Carstensen & Turk-Charles (1994), as Table 25 and Table 26 display that participants in the Late Adulthood groups produce a higher self-relevance score for neutral items than negative items, suggesting that emotional items are not always remembered more effectively than neutral items amongst older adults. Fundamentally, the consistency of the findings from

hypothesis VI indicates that there could be a component of visual and auditory human memory that allows for the self-regulation of emotional items, but the self-regulation of emotions declines with age, which opposes the assumption proposed by the socioemotional selectivity theory (Carstensen, 1993, 1995, 2005; Carstensen et al., 2003; Carstensen et al., 1999) that older adults have an increase in self-regulating positive emotions due to a conscious and unconscious awareness of the time they feel they have left in life.

7.2. *Implications of the Present Study's Findings*

7.2.1. Theoretical Implications

To date, no research has been able to explain how visually presented emotional items that are measured on the characteristics of valence and arousal can affect how younger, middle-aged and older adults remember previously encountered items. In addition, there is no available research to suggest whether or not the visual presentation of emotional items improves remembering in contrast to the auditory presentation of emotional items. However, the findings of the present study although somewhat tentative due to their originality do appear to correspond with some of the previous concepts held, whilst challenging others to the extent that the present study's findings indicate a new theoretical stance on how individual's from different adult age groups (i.e. Early, Middle and Late Adulthood) ability to remember previously encountered items should be considered in future research.

The present study's findings showed evidence from testing hypotheses I, II and IV to suggest that both the standard remember/know (Gardiner., 1988; Tulving,

1985) and the modified remember/know (Sheridan & Reingold, 2011) procedures are unreliable for measuring the dual process concept of remember and know, primarily because the standard and modified remember/know procedures produce inconsistent results for correct know and remember responses (i.e. hypotheses I and II), and the modified remember/know procedure fails to have correct know responses that significantly differ from the standard remember/know procedure (i.e. hypothesis IV). Nevertheless, the findings of hypotheses I, II and IV should not disregard the dual process theory of recollection and familiarity, as it is experimentally observable that individual's from different adult age groups produce responses that resemble the notion of remember (recollection) and know (familiarity) responses (i.e. the participants acknowledge that they either remember or know previously encountered items). With that said, the findings from testing hypothesis VI should be concurrently considered with remember/ know responses and aging, because it was revealed that adults consistently self-regulate emotions, even if the ability to self-regulate emotions declines for positive, negative and neutral emotions as an individual ages. However, the findings of hypothesis IV also reveal that the self-regulation of emotions in aging should not be considered from the socioemotional selectivity theory (Carstensen, 1993, 1995, 2005; Carstensen et al., 2003; Carstensen et al., 1999). The findings of hypothesis III reveal that visual recognition memory is not superior to auditory recognition memory, which denotes that more research is required studying both sensory modalities. The findings of hypothesis V reveal that response bias does not have a significant effect on the remember and know responses for emotional items within aging.

From the findings of hypothesis I to VI, future research into emotion, aging and remembering must maintain the theoretical position that remember and know responses represent the ways in which individuals can recall their past experiences, but with a decrease in self-relevance scores being prevalent amongst aging adults, the self-regulation of emotions may have an impact on how remember and know responses are recorded. For instance, a higher self-regulation of emotions by younger adults in comparison to middle-aged and older adults could be the factor that allows them to remember more previously encountered items. However, the perspective should be taken that an individual's self-regulation of emotions in the form of self-relevance scores are linked to an individual's everyday encounters, with everyday encounters being unique to the individual, thus self-relevance scores could an infinite number of associations with an individual's everyday experiences (i.e. a high self-relevance score could be given to a word that an individual experiences in several contexts such as social or cultural). In addition, humans should not be thought of as a species that has a hierarchy of superior sensory modalities ranging from visual (the most superior) to olfactory (the least superior), especially as the auditory sensory modalities has been shown to perform the functioning of remembering parallel to the visual sensory modality.

7.2.2. Methodological Implications

As mentioned previously, the remember/know procedure has continued to produce conflicting results within the present study that was appeared to be apparent after examining the previous research into emotion, aging and remembering. Yet, with the participants expressing verbally qualitative

responses to the researcher to emphasize that they remember or know previously presented items (i.e. they can state remember and know as separate functions of recognition memory), this structure for obtaining remember/know responses to reflect the dual-process assumptions of recognition memory would remain useful in future research. Nevertheless, the methodology of the remember/know procedure needs to be restructured based on the findings from hypotheses I to VI, which indicate the necessity for components that incorporate the capacity to measure all five of a human's sensory modalities in potentially one experiment (although what sensory modalities are included into the developed remember/know procedure would depend on the sensory modalities that are of interest to a researcher) and a method of recording the self-relevance of presented items to the individual. Consequently, the present study proposes the following preliminary methodology to be used to measure the impact of emotional items on aging and remembering within future research, taking into consideration the aforementioned restructuring.

7.2.2.1. The Developed Remember/Know Methodology

Similarly to the visual and auditory standard and modified remember/know experiments conducted within the present study, the developed remember/know procedure could implement the same; method of recruitment for participants (i.e. opportunity sampling and inclusion and exclusion criteria), experimental design that allocates participants into three adult age groups (i.e. Early, Middle or Late Adulthood), assessment measures such as the PANAS and NART, apparatus such as superlab 4.0.7, and the same selection of positive, negative and neutral valence (neutral arousal) items using the VAS. In addition, the study

phases for the developed remember/know procedure could be the same as the standard and modified remember/know procedures (i.e. items are presented individually, at a presentation rate of 1500 milliseconds and an inter-stimulus interval rate of 2000 ms), with the option remaining that any type of sensory items such as visual or auditory or both can be examined simply by presenting them in the study and test phases. However, it would be the test phases of the developed remember/know procedure that will display the difference in methodology.

After completing the interval phase (e.g. completing the NART in a 10 minute time frame), the test phase would ensue, with the target items from the study phase being individually presented along with the same number of distracter items. Immediately after each item has been shown, the participant will select on an experimental keypad ‘yes’ to indicate they have seen the item within the study phase, and ‘no’ if they feel that they have not seen the item within the study phase. Again, if the participants select ‘no’ then they will be presented with the next item, but if they select ‘yes’ then the participants will be asked whether they ‘remember’, ‘know’ or ‘know/remember’ an item. The remember and know responses will function as categories that represent recollection and familiarity, respectively. The know/remember response will function as a response that participants can select if they feel that an item was initially familiar to them, but eventually retrieved a state of remembering. This response agrees with the notion by Jacoby et al., (1997) that remember responses are instructed to be selected even if an individual experiences remember and know for an item (i.e. an individual finds an item familiar, but eventually remembers it). However,

the developed remember/know procedure will actually include a response to measure the possibility of remember and know responses occurring simultaneously, as the author of the present study predicts its inclusion for the first time could reduce the incidence of conflicting findings in comparison to the already tested bias-free remember/know experiments (i.e. using remember/know procedures without calculations such as the independence formula) (Naveh-Benjamin & Kilb, 2012; Ozubko et al., 2012; Sheridan & Reingold, 2011) and the remember/know experiments that attempt to compensate know responses using calculations (research reviewed by Wixted, 2009 and Yonelinas, 2002).

Once a participant has recorded either a remember, know or know/remember response, a question will appear on top of the screen which will read ‘does the item have any relevance to you?’ The question will have seven numbered descriptions below it (see Appendix 13 for the layout of the descriptors and explanations for the meaning of each one). As shown in Appendix 13, the participants have the opportunity to select from the following responses; ‘1-Personal Identity e.g. physical appearance’, ‘2- Social e.g. family, workplace’, ‘3-Cultural e.g. religion, nationality’, ‘4-Environmental e.g. wildlife’, ‘5-No direct involvement to the self’, ‘6-Minimal or no relevance’ and ‘7- Other’. The selected descriptor achieves a score of one, with each descriptor having a possible overall score that is within the number of presented target items (e.g. if 100 target items are presented, then each descriptor can achieve a score which is between 0-the minimum to 100-the maximum). These seven responses coupled with the remember, know and know/remember have the intention of obtaining

self-relevance scores that provide a greater insight into the way in which different adult age groups remember, know or know/remember emotional items, and self-regulate these emotional items in reference to their everyday existence. For instance, an experiment using the developed remember/know procedure may reveal that younger adults produce higher correct remember responses and personal identity self-relevance scores for positive items, whereas older adults produce higher correct know responses and minimal or no relevance for neutral items.

7.2.3. Practical Applications

Although the present study findings are not directly applicable to clinical populations, the findings of the present study could be used to reassess how visual and auditory recognition performance is considered for clinical populations that require continual care. Instances were a reassessment of visual and auditory recognition memory is needed for examining age related diseases such as dementia, which are said to be on the increase due to an ‘aging population’ (i.e. individuals in a population are living longer) (NHS, 2013) and is estimated to effect 106.4 million people worldwide by 2050 (Chamberlain et al, 2011). Dementia is the general term given to several forms of diseases (e.g. Alzheimer’s and Lewy Body Dementia) that are associated with an ongoing and gradual decline of cognitive function, with one of the shared declining functions amongst these different forms of dementia being a severely impaired ability to remember everyday experiences. Without the ability to remember their everyday experiences, an individual with dementia loses empathy for emotional items (e.g. understanding and compassion for a person

whom may be upset) and finds it increasingly difficult to make decisions within the present, outcomes which together could have serious consequences on an individual's safety. For instance, an individual with dementia may not be able to comprehend that their current actions is provoking another individual to be aggressive towards them, due to their inability to learn from their past experiences. Unfortunately, it is still unknown why individuals with dementia struggle to remember their past experiences.

However, previous recognition memory research has provided findings to insist in explaining some of the potential causes for a reduced ability to remember in individuals with dementia (e.g. Aggleton et al, 2011; Saunders and Aggleton, 2007; Tsivilis et al, 2008; Vann et al, 2009). For example, Aggleton et al (2011) found that patients with dementia appear to have sufficient damage to their medial temporal lobe that continues to decline with age. Primarily, Aggleton et al (2011) argued that damage to the medial temporal lobe indicates that brain regions such as the hippocampus and amygdala (brain regions that are considered to be important for interpreting emotional items) are unable to intake visual information that is associated with emotional events (e.g. other people expressing distress in close proximity to the individual with dementia) as efficiently as a healthy individual, thus leading to a decrease in remembering of past experiences for the individual with dementia. From research findings such as Aggleton et al (2011) some predominant initiatives have been implemented whereby individuals with dementia will have many large visual items (i.e. clocks and notice boards for messages) placed around their everyday settings such as their home, in an attempt to make items that relate to an individual with

dementia be more receptive to the damaged brain regions. Essentially, it is hoped that more visual information will be received for remembering, if the visual sensory modality is constantly in view of items that relate to the individual.

Nevertheless, if the present study's findings with regards to there being no significant differences between visual and auditory recognition memory performance were taken into consideration, then individuals with dementia could also in effect have damage to the brain regions that are associated with the intake of auditory information. If auditory recognition memory does play an equal role to how an individual with dementia remembers their past experiences, then by focusing initiatives on improving the retrieval of visual information will not be compensating the declining intake of auditory information. Consequently, future research that has a direct implication on clinical populations such as individuals with dementia must consider investigating how auditory remembering is impacted by cognitive damage, and if it found that auditory recognition memory is consistently affected in these clinical populations, then initiatives that implement more auditory items that related to the individual's everyday existence are also required.

7.3. *The Present Study's Limitations*

It is important to note that the present study did have some limitations. The first limitation to note is that the sample size within each of the visual and auditory (remember/know and self relevance questionnaires) age groups was relatively small, with only 16 participants being allocated to each of the three age groups.

It has been suggested that a small sample size could decrease the statistical power of a test, leading to the misinterpretation of any effects found in the results of a study (Cohen, 1992). For instance, a small number of younger, middle-aged and older adults would not be sufficient enough to be representative of the target population (i.e. non-clinical sample) within demographic location. Potentially, the decrease in statistical power could have increased the probability of a type I error occurring, meaning that any significant results found in the findings could be due to coincidence (Coolican, 2009). Consequently, if the present study was to be replicated, then it would require a larger sample size in order to reduce the probability of type I errors, increasing the research's overall robustness.

However, the present study included several interventions, which would have increased the reliability of the results obtained. For instance, order effects that are associated with conducting repeated measures design (Gavin, 2008), were experimentally considered by having 50% of participants from each age group completing the standard-modified experimental sequence and the other 50% completing the modified-standard experimental sequence, and were also statistically considered by conducting Mann-Whitney U tests on the experimental sequences. These Mann-Whitney U statistical analyses revealed that there was no significant impact of the order to which a participant completed the standard and modified visual or auditory experiments (see tables 15, 24 and 25 for the results of these Mann-Whitney U tests). Another intervention such as the PANAS, measured the participant's mood states once prior to commencing each standard and modified visual or auditory experiment

(i.e. a mood score was obtained for each experiment a participant participated in). The use of the PANAS scores ensured that participants in the present study were not included if there mood was not parallel to that of a non-clinical sample (Crawford & Henry, 2004). As a result, these interventions such as the previously mentioned ensured that the sample of participants used in the present study, although relatively small in size, were being tested to with the intention of representing the target population of the present study, which in turn should have improved the reliability of the obtained results.

The second limitation to note is the use of three-way Mixed ANOVA's as a test of non-parametric statistical analysis. As with other factorial ANOVA's, there are technically no non-parametric equivalents to a three-way Mixed ANOVA (Coolican, 2009). However, there are robust methods that can be used instead, which require the 'R Plugin' for SPSS in order to run the statistical analysis (Wilcox, 2005). The R Plugin would have applied a deterministic mathematical function to each point in the present study's dataset, transforming the data so that it more closely resembles the assumptions of the statistical inference (i.e. the conclusions drawn from the dataset) (Field, 2009). The benefit of transforming the present study's dataset using R Plugin would have been that it could have improved the interpretability of the results of the present study, allowing for a clearer understanding of any significant results that were achieved (Dalgaard, 2002). With that said, transforming any dataset can be problematic, as the conclusions that can be drawn from transformed data do not always accurately transfer to the original pre-transformed measurements (Howell, 2007). Consequently, unnecessarily transforming a dataset could lead

to the transformed data identifying a different significant pattern of results then what the original dataset would have concluded (Tabachnick & Fidell, 2007). As a result, the present study opted for conducting three-way Mixed ANOVA's instead of using R Plugin, because the author believed that transforming the dataset could have the potential for making the results of the present study unreliable.

The third limitation to note is with regards to the use of the VAS assessment measure, which was specifically designed for the present study. Indeed, the VAS was unique in the sense that it adopted the technique used in Bradley and Lang's ANEW (1999) to ask participants from similar cultural backgrounds to the participants that completed the visual and auditory remember/know experiments and self-relevance questionnaires (i.e. the participants first language was English and they all lived within England) to rate the perceived level of valence and arousal for the disyllable words included in all the experiments, using a scale from 1 to 9 (1 equalling a low valence or arousal score and 9 equalling a high valence or arousal score) in order to attain words that were perceived to be positive, negative or neutral in valence with neutral arousal. However, due to individuals having different life experiences, the interpretation of a words level of emotional valence and arousal will vary depending on the individual. For instance, the word 'car' could be perceived as having positive valence and high arousal to an individual that has recently bought a brand new car, or the word 'car' could be perceived as being negative valence and high arousal to another individual who had been involved in a serious road accident. Therefore, the limitation of the VAS is that it does not

take into account the individual differences relating to the interpretation of the words used in the present study, which in effect could have an impact on the validity of the results. With that said, it would have been virtually impossible to adapt the words used in the VAS to each participant, simply because even if there was an extensive amount of time to measure each participant's valence and arousal scores for each item at the time of the study, it does not mean that the participants perceptions of the items will continue to change during the course of the study. For instance, an individual may find the word 'car' to be a positive item during the study phase, but then during the test phase, they could instantly remember an occasion when they had an accident in a car, which then changes their perception of the word 'car' from positive to negative. Consequently, even though the VAS does not take into account individual perceptions of the items used in the experiments, it has recorded mean valence and arousal scores from participants in the same cultural settings as the participants used in the remember/know experiments and self-relevance questionnaires, which is effect indicates that the valence and arousal scores are accurate to the time the VAS was completed.

7.4. *Potential Scope for Future Development*

As mentioned within the previous sections, possibilities for future development have been discussed with regards to the present study's findings such as continuing to investigate auditory recognition memory for healthy and clinical populations. In addition, there has been the proposal of a developed remember/know procedure in recognition memory research, which takes into consideration an ability to self-regulate emotional items that continues to decline

with age. However, there is one other future research opportunity into the identification of why individuals produce ‘false remember’ responses that the author of the present study believes may require further investigation, although it must be noted there was no recorded findings for false remember within the present study. Thus, false remember responses within the present study were only an experimental observation made by the author, during the test phases of the remember/know experiments.

False remember responses were observable in the present study when a participant had to state that a word within the test phases of the remember/know experiments was remembered or known, and occurred when a remember response was incorrectly identified for a target item. After examining the recognition literature further, the occurrence of false remember responses has been extensively researched before (e.g. Deese, 1959; Gallo & Roediger, 2003; Geraci & McGabe, 2006; Neuschatz et al., 2001; Roediger & McDermott, 1995). However, these studies have only focused on false remembering in visual recognition memory and have not examined false remembering with regards to the impact of emotional information on aging.

Indeed, there could be the option of future research to statistically analysis the incorrect remember responses for the present study as evidence of false remembering, because false remembering is the incorrect identification of remembered words. This could perhaps satisfy the lack evidence into false remembering within auditory recognition memory, and the lack of evidence into false remembering for emotional information and aging. Nevertheless, statistically analysing the incorrect remember responses of the present study

would be unable to answer two important questions relating to the general occurrence of false remembering. Firstly, a statistical analysis would be unable to answer the question ‘of the incorrect remember responses, how many responses are due to a genuine false identification of the presented items? (i.e. believing that an item was present when it was not) and how many responses are due mistakenly selecting that a word was seen before?’ Primarily, statistical analyses of the incorrect remember responses would have been unable to answer the first question, because the aim of the present study was not to categorise the reasons why individuals from different age groups incorrectly select remember responses. Secondly, statistical analyses alone of the incorrect remember responses would not possess the measurement needed to answer the question ‘Why does an individual that produces a genuine false identification of a remember response relate it to one of their own past experiences?’ As observed in the means and standard deviations for the visual and auditory remember/know experiments within the present study, the incorrect remember responses tend not to constitute a substantial proportion of the total target words (in some instances only one incorrect remember response is recorded), which indicates that there are potentially some instances when the participants in one age group may only record all of their incorrect remember responses by mistakenly selecting target words, whereas another age group may only record all of their incorrect remember responses by genuinely misidentifying target words. As a result, the small chance of producing an incorrect remember response for word by an individual believing the word to be of some resemblance to their past experiences is arguably a unique event to

the individuals of a particular age group, and so qualitative measurements such as interviews may be required in future research in order to understand the individualistic occurrence of these to the individuals.

7.5. *Conclusions*

The findings of the present study found conflicting results when using the standard and modified remember/know procedures to examine the impact emotional valence (neutral arousal) items have on aging and remembering. However, by comparing visual and auditory recognition memory and producing a questionnaire that measured the self-relevance of emotional items, the present study demonstrated that visual recognition memory is not superior to auditory recognition memory and humans appear to have an ability to self-regulate emotions that decreases as an individual ages. Indeed, there were possible limitations to the design of the present study, which questioned the sample size used for each age group, the choice of statistical analysis and the selection of emotional items. Nevertheless, the effect these limitations had on the results was limited by the implementation of different interventions throughout the present study (i.e. the VAS measured the perceived valence and arousal of different English words from individuals that shared similar cultural characteristics as the participants used in the remember/know experiments and self-relevance questionnaires). With that said, the research design used in the present study (the use of the remember/know) is currently not reliable for measuring recognition memory from a dual-process perspective and with the findings for the self-relevance scores revealing a self-regulatory component to

human aging and remembering, a developed remember/know procedure has been proposed for the use in future recognition memory research.

By taking into consideration the developed remember/know procedure, it is anticipated that future research will begin to investigate auditory recognition memory more extensively along with visual recognition memory, and research that has attempted to understand why clinical populations such as individuals with dementia have a decline in their capacity to remember their past, will reassess the findings they have attained when using the standard remember/know. If future research focuses on these preceding concepts, there are the possibilities that human's will be thought of as a species that has more than one superior sensory modality for remembering (i.e. not just visual), and that diseases like dementia will eventually be understood to the extent that they may become curable.

In conclusion, although the present study has not directly provided an answer to the central question 'how does emotions affect aging and remembering?' the present study has produced findings from testing six hypothesis, which has lead to the proposal of a developed remember/know procedure that has the potential to extensively answer the central question, if it is given the opportunity to be used in future recognition memory research.

8. References

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9. Appendices

9.1. Appendix 1- Consent Form

The University of Huddersfield

The effects visual word stimuli have on human memory

Participant number:

Student Researcher: Joe Keeley

Consent form

Thank you for taking the time to consider participating in this research. The following questions are to ensure that you understand the purpose of this research and that you consent to participating. If you have any questions about the research or do not understand any of the questions stated below, please inform the experimenter now.

Please circle either 'YES' or 'NO' as your response to the following questions;

Do you understand the purpose of the research and do you feel like you have had a chance to ask questions you may have about the research?

YES NO

Do you acknowledge you can withdraw your data from the research up to the point at which your data has been made anonymous?

YES NO

Do you understand that you can choose not to answer any question without being given a detailed explanation as to why you are being asked a question?

YES NO

Do you accept that your results will be used in a research report, which could be read by others or published at a later date providing that you remain anonymous?

YES NO

Do you understand that you can withdraw from the experiment at any point?

YES NO

If you are happy that you have been fully informed of the nature and aims of this research and consent to taking part, then please could you provide your name, signature and today's date on the next page.

Thank you.

Joseph Keeley (Student Researcher)

Name of Participant:

Signature:

Date:

Name of Researcher:

Signature:

Date:

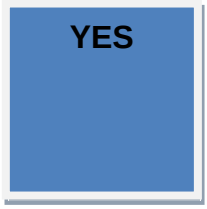
Note: two copies of this consent form should be completed, with one copy being retained by the participant and the other copy to be retained by the researcher.

9.2. Appendix 2- Standard Remember/Know Experiment Keypad Responses

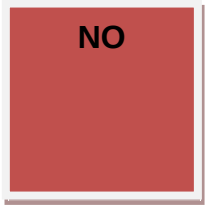
ACTUAL TEST

Test Phase

This is now the test phase of the practise test. If you recognise seeing a word from the study phase then press the **blue 'YES' key**, if you do not recognise the word then press **the red 'NO' key.**

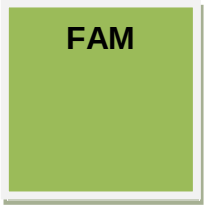


You recognise the word from the study phase



You do not recognise the word from the study phase

If you recognise a word from the study phase and press the blue 'YES' key, a new set of instructions will appear on screen. Read the instructions and either press **green 'FAM'** if the word is familiar or press the **orange 'REC'** if you recollect the word.



The word is Familiar

You recollect the word

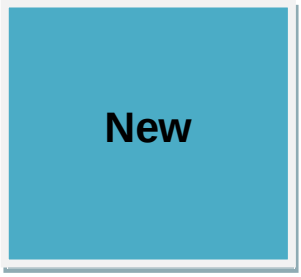
9.3. Appendix 3- Modified Remember/Know Experiment Keypad Responses

ACTUAL TEST

Test Phase

The test phase is the part of the experiment, which will require you to state whether you recognise any of the words from the study phase you had previously completed. You will now be presented two word trials at a time (one above the other) and asked two questions;

The first question will ask you to state whether either of the words is ‘New’, ‘Remember’ or ‘Know’. The ‘New’ key should be pressed if you believe neither of the words presented was in the study phase, the ‘Remember’ key should be pressed if you remember specific details about a past encounter with one of the words, and the ‘Know’ key should be pressed if one of the words seems familiar. The keys on the keypad for these three responses will be as follows;

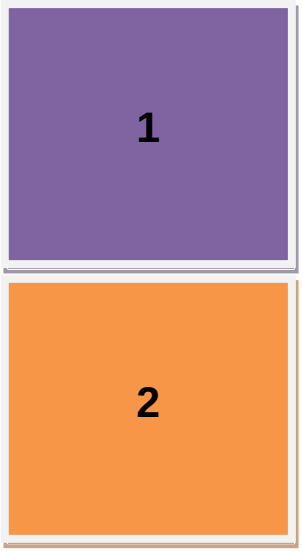


Neither word was in the study phase

You can remember specific details about one of the

One of the words seems familiar to you.

The second question will ask you to indicate which of the two words in each trial you thought was in the study phase by pressing ‘1’ or ‘2’ on the keypad. Although only 50% of the trials will contain a word from the study phase, you are still asked to state which of the two words you think was in the study phase regardless of your response to the first question. The keys on the keypad for stating which word you consider to be in the study phase within each trial will be as follows;



For the word presented on the top

For the word presented on the bottom

To ensure that you understand the procedure for the test phase, you are now asked to complete the brief practise test phase. This will present you with three trials.

9.4. Appendix 4- Participant Information

The University of Huddersfield

The effects visual word stimuli have on human memory

Participant number:

Student Researcher: Joe Keeley

Participant Information

Dear participant,

I am an MSc by research student at the University of Huddersfield and I am conducting a memory experiment, which you have been invited to take part in. Before you decide whether you would like to participate or not, it is important that you read the following information provided, as it will explain the research further and will tell you what your participation involves. Please take time to read through this information and feel free to ask any questions if anything seems unclear or you would like further information.

Thank you for reading this.

What is the aim of this research?

This research aims to study the way in which adults remember visually presented words.

Why have you been invited to participate?

You have been invited to participate in this study because you are aged 18 and above and you are available on one of the allocated experiment days. Approximately 96 participants in total will be asked to take part in this study between the months of May and September 2012.

What will be asked of you if you decide to take part?

For the first five minutes of the experiment, I will discuss with you the procedure of the experiment and how you will need to respond depending on your answer. Preceding this discussion, you will be asked to sit at a computer desk and complete a short practise test on a computer or laptop.

During the practise test, you will be asked to read a list of words (which are presented individually) and respond to each word by stating whether you find the word ‘pleasant’ or ‘unpleasant’. This is referred to as the study phase. Because the study phase of the practise test is relatively short, you will then be asked to immediately complete the test phase. During the test phase of the practise test, you will be asked to read another list of words and respond to them as will be explained to you in the discussion at the beginning.

Once you have completed the practise test, you will then be asked to complete the memory test. The memory test has the same procedure for the study and test phases as the practise test. However, it will take a longer time to complete (i.e. you will be required to read more words) and there will be an interval phase in between the study and test phases. During the interval phase, you will be asked to complete the National Adult Reading Test (which will take approximately ten minutes to complete).

How will this study maintain your confidentiality?

All information that is provided will be kept anonymous and will not be made accessible to anybody else (i.e. third parties) as stated in the Data Protection Act (1998). You will be assigned a participant number, which you must keep hold of in case you want to withdraw your information from the research at a later date.

What will happen if you do not want to participate in the study or you change your mind about participating during the study?

Basically, it is your choice whether you decide to participate in this study or not. If you do decide to participate, then you will be provided with a consent form to ensure you understand the purpose of the research and you consent to participating, which will be signed by yourself and me. Even once signing this consent form, you still maintain the right to withdraw from the study at anytime without providing a reason and without detriment to yourself.

Your participation will be voluntary

Participation in this research is voluntary and there will be no repercussions if you decide not to participate. Please be reminded, that if you do decide to participate in this research then you do not have to answer any questions which you do not want to.

Time required for participation

The estimated time of the experiment is thirty minutes.

Where will the experiment take place?

If you decide to participate, you will be asked to conduct the experiment in a university lab room either on a computer (Huddersfield campus) or a laptop (Barnsley or Oldham campuses).

Will the results of the study be published?

My ambition is to publish the results of this study in a respected journal, in order to enhance the knowledge further within memory research.

If you do decide to participate in this study and then decide at a later date that you do not want your results published, then you will be able to withdraw your results. However, you will only be able to withdraw your results up until the data has been anonymised (i.e. prior to the analysis of all the participant's results).

Contact details for further information

If you have any questions with regards to any part of this research then contact:

Supervisor: Dr Tina McAdie

Email address: t.mcadie@hud.ac.uk

Co-Supervisor: Dr David Peebles

Email address: d.peebles@hud.ac.uk

Student Researcher: Joe Keeley

Email address: U0852334@hud.ac.uk

9.5. Appendix 5- Standard Remember/Know Experiment Debrief

The University of Huddersfield

An experimental comparison on the effects visual emotional stimuli has on aging.

Participant number:

Student Researcher: Joe Keeley

The aim of this research is to measure recognition memory with regards to emotional valence (positive and negative) and neutral stimuli, whilst controlling for emotional arousal (i.e. positive, negative or neutral stimuli could be either calming or exciting). The results of this research reflect the 'standard' Remember/Know measurement of recognition memory and will be compared with the results from a 'modified' Remember/Know measurement of recognition memory.

Prior to the start of the experiment, we firstly discussed the differences between recollection and familiarity responses and how these assume remember and know responses. To improve your understanding of these differences, you completed a practise version of the experiment before you were asked to move onto the remember/know recognition memory test (i.e. the extended version of the practise test).

You were then visually presented on a computer screen an individual word, to which you were asked to respond whether the word was pleasant or non-pleasant. This process formed the part of the experiment known as the study phase, which was the set of words you had to try and remember.

After the completion of the study phase, there was a ten minute (stop watch recorded) interval period. During this period, you were asked to complete the National Adult Reading Test (NART). The NART required you to read aloud a list of words and to pronounce correctly as many as possible. Although the results of the NART are not essential to the experiment, you were encouraged to participate so that you could not attempt to revise the words you had seen in the study phase.

Finally, after the interval phase you then completed the test phase. During this time, you were presented another set of visual words, which where an inter-mix of the words from the study phase and new words. The test phase was the process of the experiment which tested whether a presented word was familiar & 'known', recollected & 'remembered', or was a word you felt you had not seen in the study phase.

I would like to remind you that the results of this experiment will be held anonymously in accordance with the data protection act (1998) and that if you wish to withdraw your data from the results, then you have up until the results have been published to do so (approximately January 2013).

If you would like to discuss the research into further detail, then feel free to use the contact details provided on the next page;

Student Researcher: Joe Keeley

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If you feel this research has affected you in anyway, details have been provided below of some support networks provided by the University of Huddersfield (if a student of the University of Huddersfield) and within the areas of Huddersfield and Manchester;

The University of Huddersfield counselling service

Website: www.hud.ac.uk/wellbeing/needhelpwithaproblem/studentcounselling/

Email address: internalcounsel@hud.ac.uk

Note: Services available during term time only.

Samaritans- Huddersfield

Website:www.samaritans.org/Huddersfield/

Phone: (01484) 533388

Email address: jo@samaritans.org

Samaritans- Manchester & Salford

Website: www.samaritans.org/manchester/

Phone: (0161) 236 8000

Email address: jo@samaritans.org

Thank you for your participation.

9.6. Appendix 6- Modified Remember/Know Experiment Debrief

The University of Huddersfield

An experimental comparison on the effects visual emotional stimuli has on younger, middle-aged and older adults.

Participant number:

The aim of this research is to measure recognition memory with regards to emotional valence (positive and negative) and neutral stimuli, whilst controlling for emotional arousal (i.e. positive, negative or neutral stimuli could be either calming or exciting). The results of this research reflect a 'modified' Remember/Know measurement of recognition memory and will be compared with the results from the 'standard' Remember/Know measurement of recognition memory.

Prior to the start of the experiment, we firstly discussed the differences between recollection and familiarity responses and how these assume remember and know responses. To improve your understanding of these differences, you completed a practise version of the experiment before you were asked to move onto the remember/know recognition memory test (i.e. the extended version of the practise test).

You were then visually presented on a computer screen an individual word, to which you were asked to respond whether the word was pleasant or non-pleasant. This process formed the part of the experiment known as the study phase, which was the set of words you had to try and remember.

After the completion of the study phase, there was a ten minute (stop watch recorded) interval period. During this period, you were asked to complete the National Adult Reading Test (NART). The NART required you to read aloud a list of words and to pronounce correctly as many as possible. Although the results of the NART are not essential to the experiment, you were encouraged to participate so that you could not attempt to revise the words you had seen in the study phase.

Finally, after the interval phase you then completed the test phase. During this time, you were shown two words in the centre of the computer screen that were an inter-mix of words from the study phase and 'new' words. You were then asked to state if any of the words had been presented in the study phase and whilst being informed that only 50% of the trials contained the words from the study phase. The test phase was the process of the experiment which tested whether a presented word was familiar & 'known', recollected & 'remembered', or was a word you felt you had not seen in the study phase.

I would like to remind you that the results of this experiment will be held anonymously in accordance with the data protection act (1998) and that if you wish to withdraw your data from the results, then you have up until the results have been published to do so (approximately January 2013).

If you would like to discuss the research into further detail, then feel free to use the contact details provided on the next page;

Student Researcher: Joe Keeley

Email address: u0852334@hud.ac.uk

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Website: www.samaritans.org/manchester/

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Thank you for your participation.

Appendix 7

Table 12- The Means and Standard Deviations for the three Age Group's Visual Standard and Modified Remember/Know Positive (Pos), Negative (Neg) and Neutral (Neu) Recognition Memory Performance Mean Scores.

Visual Remember/Know Experiments	ADULT AGE GROUPS								
Standard Remember/Know Experiment	Early Adulthood			Middle Adulthood			Late Adulthood		
	Pos	Neg	Neu	Pos	Neg	Neu	Pos	Neg	Neu
Remember	Mean (Standard Deviation)								
Correct Responses	13(2.05)	13(2.50)	7(3.61)	11(2.09)	11(2.15)	5(1.30)	10(1.87)	8(1.78)	4(1.27)
Incorrect Responses	1(0.90)	1(1.06)	1(1.01)	3(0.90)	2(1.13)	2(1.10)	1(0.74)	2(1.19)	4(1.25)
Response Bias (Total)	0.5(0.14)	0.5(0.15)	0.4(0.13)	0.5(0.13)	0.4(0.16)	0.2(0.62)	0.6(0.11)	0.3(0.12)	-0.2(0.76)
Know	Mean (Standard Deviation)								
Correct Responses	4(1.55)	4(1.81)	9(3.46)	4(1.90)	5(3.28)	9(3.01)	8(1.75)	6(1.16)	7(1.69)
Incorrect Responses	2(1.30)	2(1.10)	3(1.49)	2(1.28)	2(1.13)	4(1.72)	1(0.64)	4(0.85)	5(1.58)
Modified Remember/Know Experiment	Early Adulthood			Middle Adulthood			Late Adulthood		
	Pos	Neg	Neu	Pos	Neg	Neu	Pos	Neg	Neu
Remember	Mean (Standard Deviation)								
Correct Responses	10(1.30)	13(1.95)	5(1.28)	8(1.40)	11(1.44)	4(1.25)	7(1.50)	5(1.10)	2(0.80)
Incorrect Responses	1(0.68)	1(0.60)	1(0.74)	1(0.80)	3(0.82)	1(0.90)	3(0.90)	3(0.80)	1(0.73)
Response Bias (Total)	0.4(0.13)	0.5(0.13)	0.4(0.14)	0.4(0.14)	0.4(0.12)	0.2(0.17)	0.3(0.12)	0.3(0.11)	-0.2(0.76)
Know	Mean (Standard Deviation)								
Correct Responses	6(1.53)	4(1.49)	10(2.06)	8(2.33)	6(1.46)	10(2.83)	6(2.70)	8(2.19)	9(1.06)
Incorrect Responses	3(1.84)	2(1.07)	4(1.61)	3(2.19)	4(1.75)	5(2.17)	4(1.81)	4(1.44)	8(0.99)

Appendix 8

Table 13- The Means and Standard Deviations for the three Age Group's Auditory Standard and Modified Remember/Know Positive (Pos), Negative (Neg) and Neutral (Neu) Recognition Memory Performance Measure Scores.

Auditory Remember/Know Experiments	ADULT AGE GROUPS								
Standard Remember/Know Experiment	Early Adulthood			Middle Adulthood			Late Adulthood		
	Pos	Neg	Neu	Pos	Neg	Neu	Pos	Neg	Neu
Remember	Mean (Standard Deviation)								
Correct Responses	11(3.15)	12(2.50)	8(3.40)	9(2.06)	9(2.09)	7(1.93)	10(1.89)	7(1.30)	4(1.60)
Incorrect Responses	1(1.07)	1(1.11)	2(1.12)	2(0.76)	1(0.68)	2(0.88)	1(0.88)	2(0.92)	2(0.80)
Response Bias (Total)	-0.4(0.09)	-0.5(0.14)	-0.3(0.10)	-0.6(0.45)	-0.4(0.16)	-0.5(0.76)	-0.7(0.11)	-0.2(0.08)	-0.3(1.02)
Know	Mean (Standard Deviation)								
Correct Responses	6(2.97)	4(1.86)	8(3.53)	6(1.64)	6(3.28)	6(1.35)	5(1.22)	6(1.10)	7(1.60)
Incorrect Responses	3(0.96)	3(1.06)	2(1.37)	4(1.13)	1(1.13)	5(1.88)	4(1.60)	5(1.25)	7(1.21)
Modified Remember/Know Experiment	Early Adulthood			Middle Adulthood			Late Adulthood		
	Pos	Neg	Neu	Pos	Neg	Neu	Pos	Neg	Neu
Remember	Mean (Standard Deviation)								
Correct Responses	11(2.05)	12(2.05)	3(1.11)	10(1.50)	10(2.09)	5(0.92)	10(1.07)	8(1.30)	3(1.11)
Incorrect Responses	1(0.92)	1(0.70)	2(0.88)	2(0.92)	1(0.80)	2(0.80)	1(0.64)	2(0.64)	2(0.88)
Response Bias (Total)	-0.3(0.15)	-0.5(0.15)	-0.2(0.09)	-0.2(0.14)	-0.3(0.15)	-0.9(1.04)	-0.2(0.09)	-0.6(0.91)	-0.1(0.04)
Know	Mean (Standard Deviation)								
Correct Responses	6(1.16)	4(1.33)	9(2.17)	6(1.06)	6(1.06)	6(1.28)	5(1.15)	6(1.29)	7(1.15)
Incorrect Responses	4(1.73)	3(1.41)	6(2.35)	1(1.77)	1(1.60)	7(1.30)	4(1.67)	4(1.33)	8(0.99)

Appendix 9

Table 14- A Table to Compare the Recognition Memory Performance Measures for the Visual and Auditory Remember/Know Experiments

Key

V= Visual

A= Auditory

D= Different

S= Same

Visual and Auditory Experiments	Age Groups								
Standard Remember/Know Experiments	Early Adulthood			Middle Adulthood			Late Adulthood		
	Pos	Neg	Neu	Pos	Neg	Neu	Pos	Neg	Neu
Correct Remember Responses (Most)	V	V	S	V	V	A	S	V	S
Incorrect Remember Responses (Least)	S	S	V	V	A	S	S	S	A
Correct Know Responses (Most)	A	S	S	A	S	V	V	S	S
Incorrect Know Responses (Least)	V	V	A	V	S	V	V	V	V
Response Bias	D	D	D	D	D	D	D	D	S
Modified Remember/Know Experiments	Early Adulthood			Middle Adulthood			Late Adulthood		
	Pos	Neg	Neu	Pos	Neg	Neu	Pos	Neg	Neu
Correct Remember Responses (Most)	A	V	V	A	A	A	A	A	A
Incorrect Remember Responses (Least)	S	S	V	V	S	V	A	A	V
Correct Know Responses (Most)	S	S	V	A	S	V	S	A	V
Incorrect Know Responses (Least)	V	V	V	A	A	V	S	S	S
Response Bias	D	D	D	D	D	D	D	D	S

Appendix 10

Table 15- The Mann-Whitey U Test Scores for the Visual and Auditory Standard-Modified and Modified-Standard Remember/Know Experimental Sequences

Visual Recognition Memory Performance Measures	Mann-Whitney U Measures			Auditory Recognition Memory Performance Measures	Mann-Whitney U Measures		
	U	z	p		U	z	p
Visual Correct Remember Responses				**Auditory Correct Remember Responses**			
Positive	966.50	-0.374	0.71	**Positive**	872.00	-0.783	0.14
Negative	952.50	-0.486	0.63	**Negative**	894.50	-0.959	0.36
Neutral	923.50	-0.726	0.47	**Neutral**	983.00	-0.240	0.81
Visual Incorrect Remember Responses				**Auditory Incorrect Remember Responses**			
Positive	940.50	-0.617	0.54	**Positive**	1005.00	-0.064	0.95
Negative	963.50	-0.410	0.68	**Negative**	898.00	-0.987	0.32
Neutral	913.50	-0.829	0.41	**Neutral**	836.50	-1.488	0.14
Visual Correct Know Responses				**Auditory Correct Know Responses**			
Positive	921.00	-0.742	0.46	**Positive**	902.00	-0.914	0.36
Negative	1008.50	-0.033	0.97	**Negative**	1002.00	-0.861	0.93
Neutral	893.50	-0.969	0.33	**Neutral**	991.00	-0.176	0.86
Visual Incorrect Know Responses				**Auditory Incorrect Know Responses**			
Positive	904.50	-0.881	0.38	**Positive**	807.00	-1.689	0.91
Negative	960.00	-0.427	0.67	**Negative**	888.00	-1.016	0.31
Neutral	941.50	-0.575	0.57	**Neutral**	987.50	-0.204	0.84
Visual Response Bias				**Auditory Response Bias**			
Positive	981.00	-0.257	0.80	**Positive**	871.00	-1.147	0.25
Negative	911.00	-0.827	0.41	**Negative**	925.00	-0.705	0.48
Neutral	968.00	-0.361	0.72	**Neutral**	977.00	-0.287	0.77

Appendix 11- Standard Self-Relevance Questionnaire

The following words are all the stimuli that were presented in the prior experiment. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel each word relates to you or has personal importance to you. Use the following scale to record your answers:

1	2	3	4	5
Very slightly or not at all	**A little**	**Moderately**	**Quite a bit**	**Extremely**

Angel			Party
Beauty			Baby
Justice			Afraid
Ocean			Bankrupt
Snuggle			Alone
Sunrise			Illness
Laughter			Dreadful
Nature			Deceit
Friendly			Neglect
Progress			Hostile
Applause			Slaughter
Delight			Pollute
Freedom			Annoy
Wealthy			Blister
Music			Coffin
Impressed			Coward
Puppy			Danger
Hopeful			Fearful

Insult			Passage
Poison			Context
Starving			Golfer
Ugly			Kettle
Journal			Lightning
Hammer			Market
Yellow			Moment
Runner			Office
Trumpet			Scissors
Modest			Statue
Fabric			Teacher
Shadow			Whistle

Appendix 12- Modified Self-Relevance Questionnaire

The following words are all the stimuli that were presented in the prior experiment. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel each word relates to you or has personal importance to you. Use the following scale to record your answers:

1	2	3	4	5
Very slightly or not at all	**A little**	**Moderately**	**Quite a bit**	**Extremely**

Barrel			Ankle
Bathroom			Whisper
Building			Lemon
Curtains			Helpless
Dentist			Gangrene
Finger			Morbid
Gender			Nightmare
Headlight			Prison
Item			Seasick
Lightbulb			Sickness
Machine			Troubled
Mushroom			Anguish
Unit			Deformed
Window			Horror
Writer			Failure
Salute			Cockroach
Mischief			Brutal

Crisis			Talent
Enraged			Pleasure
Shameful			Carefree
Losing			Admired
Angry			Respect
Poison			Spirit
Diamond			Happy
Heaven			Thrilling
Pillow			Lively
Pretty			Circus
Joyful			Secure
Money			Soothing
Lucky			Thoughtful

Appendix 13- Self-Relevance Descriptors for the Developed Remember/Know Procedure

1. **Personal Identity-** A participant could be asked to select this response, if they feel that a presented item relates directly to their self identity. For instance, if a participant is presented with the word ‘tall’ then the participant could select the personal identity self-relevance response, because the participant considers themselves to be tall in height.
2. **Social-** A participant could be asked to select this response, if they feel that a presented item relates to their social interactions. For instance, if a participant is presented with the word ‘sister’ then the participant could select the social self-relevance response, because the participant has social interactions with their sister.
3. **Cultural-** A participant could be asked to select this response, if they feel that a presented item relates to their cultural status. For instance, if a participant is presented with the word ‘heaven’ then the participant could select the cultural self-relevance response, because they have an affiliation with a particular religion.
4. **Environmental-** A participant could be asked to select this response, if they feel that a presented item is observable within the environments that they encounter frequently and it has some relevance to their self identity. For instance, if a participant is presented with the word ‘reservoir’ and the identity the word as a remembered word, then the individual could select the environmental self-relevance response, because they come in contact with a reservoir when they go on their morning run.

5. **No Direct Involvement to the Self-** A participant could be asked to select this response, if they feel that a remembered item (from the remember/know experiment) is observable in their everyday environments, but does not directly involve them. For instance, the participant has watched a television programme whereby the presented item has been involved within, yet the item does not have any immediate consequence on the individual.
6. **Minimal or No Relevance-** A participant could be asked to select this response, if they feel that a presented item has no significance to their everyday life or if it does, then the relevance of it is minimal.