Adaptive memory: Measuring the effect of encoding strategies on word recall.

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Abstract

Recently, adaptive memory has gained much attention as it grants the possibility of insights into the ultimate causes of human memory. However, we first need to identify the proximate mechanisms. The aim of the current study was to isolate and measure the effects of encoding styles (functional, novel-survival) on word recall. A quasi-experimental design was used with a 2 x 2 x 2 mixed ANOVA with between and within-subject factors. Participants consisted of 62 adults (36 females and 26 males aged 18-61) divided into two groups for each encoding strategy. Participants were first presented with a visualization context depending on encoding strategy (functional, novel-survival) and prompted by written instructions to visualize 20 words (10 concrete, 10 abstract). Second, a distractor task was completed to prevent imagery to be held in short-term memory. Lastly, a recall task was given. Results confirmed that significantly more words were recalled in the novel-survival group, implying that this encoding strategy has a powerful effect on recall, more so than functional encoding. In the word type condition, we found a higher rate of concrete words recalled than abstract words. No significant effect could be detected between recall and gender. Interestingly, results discovered significant interaction effects between group, gender and word type, suggesting a complex relationship between these variables involved in adaptive memory.

Keywords: adaptive memory, survival encoding, memory enhancement, evolutionary psychology, imagination, visualisation, strategic retrieval, frontal lobe activation.

Introduction

Evolutionary Psychology and Memory

The purpose of this study is to investigate and compare how two types of visualisation strategies, or forms of encoding contexts (functional and novel-survival), influence the recall of a list of concrete and abstract words. Of importance in these examinations is the inclusion of gender and age as variables as they have demonstrated considerable effects on memory in previous findings (Baron-Cohen, Tager-Flusberg, & Lombardo, 2013; Van der linden & Adam, 2000) With these considered, the current study will explore the proximate mechanisms of adaptive memory within the mind-set of evolutionary theory. Previous experiments in this field (Bell, Röer & Buchner, 2015; Nairne, Pandeirada & Thompson, 2008; Nairne, 2005), have examined word recall in terms of the survival and functional-thinking encoding strategies. However, to our knowledge these two encoding strategies have never been isolated and measured separately. Within this study, we will be investigating survival-processing by using a particular form of encoding which emphasizes novelty (Soderstrom & McCabe, 2011). Doing so will allow us explore how memory operates within both of these (functional, novel-survival) fitness content parameters.

The current study will search for the proximate mechanisms of the survival-processing that has been seen in other research (Bell et al., 2015; Kostic, McFarland & Cleary, 2012; Nairne, 2005). By first identifying these mechanisms, researchers can then pursue an ultimate cause of human memory. Evolutionary psychology does not seek to replace mainstream fields, rather it hopes to build on their foundations of knowledge and provide a new aspect to be considered: the evolution of the various memory systems in homo sapiens (Nairne, 2010).

An evolutionary approach to psychology, and in this case memory, views biological phenomena in terms of Tinbergen's four questions (phylogenetic, ontogenetic, ultimate and proximate cause) (Buss, 2014; Dunbar, 2003; Tinbergen, 1951). In this way it is concerned with a strategic analysis of behaviour. If as a result of this inherited trait an individual is considerably more effective at avoiding predators, mating or finding food than previous members of his/her species, we can consider that trait an adaptation (Buss, 2014; Dunbar, 2003). From this perspective we can look at memory as a collection of mental adaptations which humans have developed to aid in survival and/or social cohesion. Organisms that are better attuned to threats and challenges would be more likely to survive. Consequently, these organisms would increase their fitness (Kostic et al., 2012).

Human memory is influenced by many aspects such as context, language, gender and age (Koriat & Goldsmith, 1996; Sherry, & Schacter, 1987). Ontogenetic improvement (changes within an individual's lifespan) of memory can also be considered as critical to our research. Adoption of specific visualisation strategies have a considerable effect on recall and knowledge of memory techniques discovered from adaptive memory research could positively impact the lives of others when implemented (Jacques & Cabeza, 2009; Johnson, 1992; Craik & Tulving, 1975).

In this study, we are concerned with two visualisation methods that serve to influence recall and can be considered in many ways. Therefore, we will refer to these respectively and interchangeably as encoding styles, foci, contexts and strategies. First, thinking about the function of a word is a particularly elaborate form of encoding which essentially highlights the semantic properties of objects (Bell et al., 2015). Known here as functional encoding, this method has a significant effect on word recall as it encourages elaborate processing. Bell et al. (2015) have proposed this to be a key factor in the survival-processing effect.

The second visualisation strategy we are concerned with is novel-survival encoding. This encoding focus has been measured and demonstrated as a powerful form of memorization strategy (Soderstrom & McCabe, 2011). Nairne and Pandeirada (2008) have investigated survival encoding (the forerunner to novel-survival encoding) and found that it outperforms other well-known methods such as threat, ease of visual imagery, ease of autobiographical memory and intentional learning in terms of recall. In turn, novel-survival encoding even surpasses survival encoding, marking it as possibly the most significant encoding focus available to date (Soderstrom & McCabe, 2011). Although these findings may be seen to challenge the specificity of priorities on a survival-tuned memory, an alternative explanation could be that a blend of deep processing and survival encoding are present which promote enhanced recall beyond either individually (Soderstrom & McCabe, 2011; Craik & Lockhart., 1972).

Main Theories and Basic Research

Biological memory and reconstructive processes. Biological memory is essentially reconstructive (Schacter & Addis, 2007). In the human brain, retrieving a memory involves reactivation of regions in the brain which were in use as the information was originally processed (Nyberg, 2002). Reconsolidation (reactivation of a memory trace) allows memories to be modified long after they are originally acquired (Nader, 2003). Retrieval of memories involve the simultaneous activity of the hippocampus with various areas within the neocortex and, specifically, activation of the prefrontal cortex, which has been positively correlated with successful recall (Hupbach, Gomez, Hardt & Nadel, 2007; Nader, 2003; McGaugh, 2000; Greenwood, 2000). Context and situational factors have significant impacts on encoding as these can be responsible for activation of specific neural pathways in the prefrontal cortex (Klein, 2013; Cohen & Conway, 2007). We do not store the raw data; we store the ability to reconstruct from the context (Schacter & Addis, 2007).

From an evolutionary perspective, the way in which specialised memory associated regions function must have been selected for because humans need to remember information within a specific context and in a similar way as to when it was first presented to the individual (Wilson et al., 2011; Brewer & Treyens, 1981; Treisman, & Gelade, 1980). Constructing memories with survival-processing allows the information to be stored in a specific and different way than everyday information. A memory becomes longer lasting, and the neural pathway to the retrieval of these words become fast-tracked and reinforced (Weinstein, Bugg, & Roediger, 2008; Johnson, 1992). An evolutionary perspective views this cognitive architecture as a mixture of specialized modules which regulate behaviour in adaptive ways (Buss, 2014). It is the purpose of these investigations into survival-processing to take those modules apart and discover how they function.

Encoding Strategies. The most prominent identified components of memory are distinctiveness, context and depth of processing (Shepherd, Gibling & Ellis,1991; Craik & Lockhart., 1972). A number of studies suggest that distinctive objects and faces are more likely to be remembered because they are represented by their location in the multidimensional space for faces, objects and other stimuli (Valentine, 1991; Gibling & Ellis, 1991). Cognitive space is relational (Neisser, 1988). If particular information is distinctive, we can speculate that it will be stored differently than other unremarkable information and will involve additional prefrontal cortex activation. Usage of this particular brain region results in a higher rate of retrieval of information (Cohen & Conway, 2007; Greenwood, 2000).

Could this capacity for attention to detail be selected for in humans? Weinstein et al. (2008) have suggested that the survival processing effect shows that evolutionary forces have shaped our memory and frontal lobe activation could provide us with that answer.
Memory may have evolved of meet the demands of a hunter gatherer lifestyle and humans have retained both procedural and implicit memory into the modern world (Buss, 2014). However, today we rely on verbal declarative memory which is constantly overloaded and so our perception and our attention becomes selective and limited. The ideal memory in this modern world devotes most of its resources on priority information, filtering out less important stimuli (Cohen & Conway, 2007; Sherry, & Schacter, 1987). When performing a novel task, more attentional control is required, resulting in a higher rate of recall (Baddeley & Hitch, 1993). Information that is not consistent with our schemas has a greater probability of remaining in our minds (Norman & Shallice, 1980; Bartlett, 1932).

Word type and recall. Memory experiments have shown how can language play an important role of setting up the context which aids in recall (Boroditsky, 2011). The frontal lobe is important in the retrieval of memories as it also is with language production and comprehension (Jaques & Cabeza, 2009), suggesting that volition and understanding of concepts is important in memory. Context in which a word is remembered influences the recall of that word later (Bell et al., 2015; Nairne et al.,2008). Furthermore, word type also affects this. Concrete words have a significantly greater tendency to be recalled in memory studies (Barber, Otten, Kousta & Vigliocco, 2013; Fliessbach et al., 2006). Adaptive memory research shows this by emphasising the role of concrete concepts as being critical in survival and may get priority within that context (Lippa, Collaer & Peters, 2010). Not only this but concrete words are much easier to visualize as images can be linked to real world concepts (Barber et al., 2013; Fliessbach et al., 2006).

Gender and memory. Investigations into gender differences on memory display significant differences in terms of autobiographical and semantic memory (Baron-Cohen et al., 2013). Some studies tend to suggest that women may have a better memory for animate objects (Horgan, 2004; Loftus, Babaji, Schooler & Foster, 1987). Is it a case that women value living things more than men (Li, 2014)? The answer may not be so simple and the mechanism may lie in our culture, genetic history or could be a by-product of both (Buss, 2014; Dunbar, 2003). Flashbulb memories are also more frequent in women than in men (Cohen, Conway & Maylor, 1994; Morse, Woodward, & Zweigenhaft, 1993). As to whether this is due to an ontological mechanism, such as cultural upbringing, or as a remnant of an evolved psychological mechanism, remains uncertain. It may be the case that it is an interaction of the two (New, Krasnow, Truxaw & Gaulin., 2007). Even in infancy, females tend to visually focus more on faces than males (Herlitz, Nilsson & Backman, 1997).

Testosterone levels in these developmental stages have an effect on this behaviour (Baron-Cohen et al., 2013). If women pay more attention to faces and people more than men, we can rationalize that a deeper level of processing is taking place which could explain the results in these memory studies (see Craik & Lockhart, 1972). Typical faces become less likely to be remembered as opposed to atypical faces, pointing once again to distinctiveness being a major factor in memory research (Horgan, 2004).

In evolutionary psychology research, there have been interesting studies that measure recall in terms of gender (e.g., Voyer, Postma, Brake & Imperato-McGinley, 2007). Spatial navigation is one notable aspect in which men and women differ with women outperforming men for location memory and objects (Silverman, Choi & Peters, 2007; Silverman & Philips, 1998). Women use more concrete landmarks for directions and also tend to show greater memory for uncommon features which have no verbal labels suggesting a memory advantage exclusive to their gender (Eals & Silverman, 1994; Lippa, Collaer & Peters, 2009).

Age and memory. Age is an aspect in which memory plays a major role in stereotypes especially in western culture and it is sometimes these judgements themselves which become responsible for bad memory in older adults (Rahhal & Hasher, 1998). In eastern cultures, growing older is not associated with declining memory and indeed these cultures show higher retrieval rates suggesting that the elderly in these cultures have better memory because of it (Levy & Langer, 1994). However, as we age we do begin to show deficits in memory which could be attributed to greater cell death in the neocortex (Raz, 2000). There are higher rates of 'tip-of-the-tongue' incidents and a higher number of people report more forgetfulness overall (Van der linden & Adam, 2000; Van der Linden, Bredart & Beerten, 1994).

Forgetfulness and effectiveness of memory are shown to be mainly associated with frontal lobe functioning (Jacques & Cabeza, 2009, Greenwood, 2000; Langenecker & Nelson, 2003; Van der Linden, 2000). As we are unable to reconstruct a context, the route to the memory becomes more difficult to reach. It is the connections of the neurons, however, that are responsible for retrieval and studies have pointed to ways in which word structure and training can be implemented to aid in older adults and recalling information (Langenecker & Nelson, 2003; Van der Linden, 2000).

Memory can be separated into two distinctions: general and specific (Koriat & Goldsmith, 1996). Generalised information is useful because it abstracts and stores information from specific situations for later use in schemas and scripts. With this kind of memory, information is resistant to aging and error. Specific memories are much less vague and imprecise and do not need to be stored for long periods like general memories (Greenwood,2000; Koriat & Goldsmith, 1996). As we age a great deal of specific memories are discarded or passed over to generalised memories. Only if information is novel and salient will it be classified as distinct and stored separately as a specific memory which is resistant to interference (Jacoby, Wahlheim, Rhodes, Daniels & Rogers, 2010). Visualisation techniques promoting prefrontal lobe activation have been shown to counteract age-related deficits in memory (Rahhal, & Hasher, 1998; Grady, McIntosh., Horwitz., Maisog, 1995).

Current Study

The current study hypothesizes that novel-survival encoding will prove as a more effective method for recall in comparison to functional encoding. Although thinking about an objects function encourages elaborate encoding and has significant effect on word recall (Soderstrom & McCabe, 2011; Anderson, 1994) we propose that the functional-thinking mechanism is a component of survival-processing. As discussed, novel-survival encoding is a dominant recall strategy in comparison to survival encoding (Soderstrom & McCabe, 2011). Consequently, the former seems to encourage distinctiveness, context and depth of processing (Shepherd, Gibling & Ellis,1991; Craik & Lockhart., 1972). We can postulate from this logic that novel-survival encoding will encourage a higher rate of recall than a functional method of encoding.

The experimental method we will employ is similar to those found in Bell et al. (2015) with one key difference; participants will be asked to rate words in accordance to how well they can visualize them, these ratings will not be factored into our statistical tests. Instead, ratings will serve to focus the participant awareness on visualization detail. Although instructions for all three tasks (Visualization methods, distractor task and recall) are based on other adaptive memory research, all have been devised especially for this study.

Secondly, we hypothesize that word type, especially of the concrete variety, will display a significant effect on recall (Barber et al., 2013; Fliessbach et al., 2006; Chiarello, Senehi & Nuding, 1987). This effect has been observed in adaptive memory research (Bell et al., 2015; Soderstrom & McCabe, 2011; Nairne, 2010). Our study will use 20 words (10 concrete, 10 abstract) from Bell et al. (2015) which measured word type in their experimentation. Of all the factors in this study, it will be interesting to record the interaction effects that word type will have on the other variables in this study. Following this, we can speculate and hypothesize on possible explanations of these findings.

Thirdly, gender will play an important role in this study. We expect, based on other finding in memory research, that gender will produce a significant effect on word recall (Baron-Cohen et al., 2013). Specifically, we expect to find that women will recall more words than men. This hypothesis stems from psychological studies that have found, although men and women use different recall strategies, the latter may possess certain memory advantages in contrast to men (Baron-Cohen et al., 2013; Morse et al., 1993). Certain types of memory systems could have been selected for in women based on environmental or social pressures in our evolutionary past (Buss, 2014; Silverman & Phillips, 1998).

Fourth, although negative correlations between age and recall have been acknowledged, the current study puts forward a directional hypothesis in which we expect no significant correlation between age and recall. This proposal is based on previous findings (Langenecker & Nelson, 2003; Van der Linden, 2000) advocating that visualisation techniques relatively negate age-related deficits. Memory structures are thought to function based on the connectivity of neurons rather than directly from cell death (Langenecker & Nelson, 2003). Based on this reasoning, novel-survival encoding is suspected to cancel out aging effects on memory due to an engagement of frontal lobe functioning (Jacques & Cabeza, 2009, Greenwood, 2000).

Lastly, the experimental findings in this study will aspire to narrow a recognisable gap in the research (see Bell et al., 2015). The identification of the proximate mechanisms concerned in the survival-processing effect is our primary objective. Regardless of how our expectations fare, the current study will attempt to report in a new vicinity of adaptive memory. For example, if results confirm that novel-survival encoding produces a higher rate of recall than that of functional encoding, we can then assume that the former possesses a larger number of cognitive mechanisms correlated with successful word recall. Following this, suppositions of how, and to what extent, a functional-thinking mechanism plays a role in the survival-processing effect can be made.

The various factors present in this study have been considered because they are all fundamental characteristics in memory research. If we record higher rates of recall for abstract words then the current understanding of how humans process word type (Fliessbach et al., 2006; Chiarello et al., 1987) will be questioned, particularly in terms of survival-processing. The prevalence of concrete word recall will similarly be confronted or re-authenticated. Results in the gender condition will confirm or rebuff an evolutionary viewpoint for gender-based advantages which have been generated from the hunter-gatherer perspective (Lippa et al., 2009; Eals & Silverman, 1994). Age-related deficits in memory may be cancelled out by visualisation strategies or persist and challenge confidence in prevention methods of the elderly (Rahhal & Hasher, 1998). The current study's results will therefore potentially dictate the future course for adaptive memory research.

Method

Participants

For this experiment, 62 participants were recruited. A convenience sample was used; 39 participants were undergraduates recruited from Dublin Business School, and 23 participants were recruited from outside of the college using an opportunity sampling method. Participants were then assigned to one of two groups (group 1 = functional focus, group 2 = novel survival focus). Group 1 consisted of 32 (19 females, Mean age 34.97, SD age = 8.98) participants and group 2 consisted of 30 (17 females, Mean age = 32.27, SD age = 11.90) participants. All who participated in the study were fluent in English and above the age of 18.

Materials

For this experiment 3 separate task sheets were created: a visualisation, distractor and a recall task. These were modelled based on similar studies which investigated adaptive memory (Nairne, 2010; Bell et al., 2015; Soderstrom & McCabe, 2011). There were two different types of instructions on the visualisation task, one for participants in each group (see Table 1). Beneath these instructions 20 words (10 concrete, 10 abstract) were listed. These were taken from a previous and similar study on adaptive memory from (Bell et al., 2015). Parallel to each word were a series of numbers ranging from 0 to 4. The numeral rankings were provided to allow participants to rate the vividness of the mental imagery created for each word as instructed.

Next, a distractor task was created. It consisted of instructions which asked participants to attempt 3 mathematical questions. A large space was provided to allow participants to write out the equations. The third, and final, task consisted of another set of instructions which asked the participants to recall the words from the visualisation task. Below these instructions, spaces were provided to allow participants to write down the recalled words. The instructions for both the distractor and recall tasks, unlike the visualisation task, remained constant throughout all groups.

Procedure

Precautions were taken and participants were informed that they would take part in a word visualisation task, they were unaware that the actual aim of the experiment was to measure recall. The goal here being a prevention of mnemonic technique usage so as to measure recall of words within the encoding contexts alone. Participants were asked to sign a consent form before taking part in the experiment and required to complete three individual tasks in the experiment. With the completion of each task, the next task was handed out.

First, participants were given a visualisation task. They filled in their age and gender and then read instructions which prompted them to visualise the below list of 10 concrete and 10 abstract words (taken from Bell, 2015) in relation to a specific scenario based on encoding focus (functional, novel survival) and then circle a number from 0 (no detail at all) to 4 (graphic detail) which rated the vividness of the mental image (see Table 1.). These ratings were not analysed within this experiment. Word imagery ratings were merely to allow the participant to consider a numeric value for their mental imagery and offset any inclinations of an ulterior motive in testing from the examiner’s point of view. Group 1 were asked to visualise the words in a functional way in which they imagined a setting in which they personally interacted (functional encoding) with each word. Group two were asked to visualise each word in relation to a zombie (novel survival encoding) setting. Steps were taken so the instructions in both groups were worded identically except in regards to encoding focus. This task lasted up to 5 minutes, at which point this page was removed and the distractor task begun.

Table 1.

Instructions Used in the Visualization Task to Emphasize Encoding Focus in Groups

Encoding Focus	Instructions
Functional	Using your imagination please visualize yourself personally interacting and/ or using the following list of words or concepts. Create mental imagery for each of these words and rate them according to the detail of each image. Do this with the following steps: 1. After reading a word, close your eyes and visualize the word in the above context. 2. Create a mental image and imagine interacting with/ personally using that image. 3. Rate the word by circling a number based on the level of detail you can imagine for the word.
Novel-Survival	Using your imagination please visualize yourself in a zombie apocalypse and you are faced with the following list of words or concepts. Create mental imagery for each of these words and rate them according to the detail of each image. Do this with the following steps: 1. After reading a word, close your eyes and visualize the word in the above context. 2. Create a mental image and imagine interacting with that image in a zombie setting. 3. Rate the word by circling a number based on the level of detail you can imagine for the word.

Note. Words that differed between each group are in italics.

For the distractor task, a sheet was placed in front of the participants and instructions were given at the top of the page to do 3 separate mathematical problems for a duration of 5 minutes. The instructions informed participants that a correct answer was not required from them at this stage of the experiment. The reasoning for this was to decrease any unknown variables such as stress or arousal which could have impacted recall. This part of the experiment, along with the lack of knowledge of the upcoming recall task, served to distract the participants so as the words they had just visualised could not be held in short term memory. A large workspace was provided below the instructions on the page to allow participants to calculate the mathematical problems by hand. Task two lasted for a duration of minutes, at which point the sheet was removed and the final part of the experiment commenced.

Once the distractor task had been removed, a recall task was given to the participants. This, similar to the other two sheets, had instructions written at the top of the page. These instructions now revealed to the participants that they were required to recall as many word as possible from when they had visualised words. Up to this point, participants were unaware of this recall task. Participants used the provided sheet to write down any recalled words. This final task was allowed to continue for a maximum of 5 minutes. When all the tasks had been completed and collected, a debriefing sheet was made available with an explanation of the entire experiment. Participants were thanked for their cooperation.

Statistical analysis and design

A quasi-experimental design was used in this study. A 2 x 2 x 2 mixed analysis of variance (ANOVA) design was used to investigate difference in word recall (the dependent variable) with encoding focus (independent variables: functional, novel survival), and gender (independent variables: male, female) as between-subject independent variables, and concreteness of words (independent variables: concrete, abstract) as within-subject independent variables. Secondly, a Pearson correlation, univariate analysis design was conducted to measure the relationship of the independent variable (age) on the dependent variable (word recall). Input data was checked for normality using a Shaprio-Wilk test and homogeneity of variance was then tested using a Levene test for equality of variance. Both of these necessary assumptions for parametric tests were confirmed by their respectable tests. Recall data was converted from count data (1 to 20) to percentage score (0.0 to 1.0) so as to be compatible with running an accurate significance testing for the 2 x 2 x 2 mixed ANOVA design. This percentage score was maintained for all tests to keep consistency. With a sample size of 62 participants, $\alpha = .05$, and a statistical power of $1 - \beta = .95.$, an effects size of $f = 1.72$, could be detected. Cohen's d, a power primer (1992) and G*power was used as an estimated measure of effect size and statistical power which was required for this study.

Ethics

The cover sheet to this study explained that the experiment was a visualisation task and it should be noted that this deception was required for the recall data to be kept free of deliberate memory techniques which could be employed by participants. This deception was explained to participants in the debriefing sheet following the final task along with the researcher's contact information should participants need to express any concerns. Although the experiment was described as anonymous, participants were required to fill out their names on the consent forms. They were informed that these would be kept separately from the rest of the data so as to allow them to remain anonymous.

Results

Table 2.

Mean score for words recalled between encoding focus, gender and word type

	Functional				Novel-Survival			
	Male		Female		Male		Female	
Word type	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Concrete	.54	.18	.46	.16	.72	.12	.76	.18
Abstract	.32	.16	.30	.16	.56	.16	.39	.13
Total	.43	.09	.38	.13	.64	.08	.58	.13

Words recalled in the third task were scored on a mark of 0 to 20 based on exact matches, however spelling errors had no impact on the scoring of the words. In order for the results to be accurately measured in a 2 x 2 x 2 ANOVA, all scoring data in this experiment was converted from count (0 to 20) to percentages via decimal digits (0.0 to 1.0). Once this had been calibrated, and the appropriate tests conducted, interpretation of the results could begin.

A 2 x 2 x 2 mixed analysis of variance (ANOVA) with encoding focus (functional, novel survival), and gender (male, female) confirmed that significantly more words were recalled from the novel-survival encoding group in comparison to the functional encoding group, F (1, 58) = 49.229, $p < .001$, $\eta^2 = .449$, (see Table 1. & Figure 1.). However, the experiment did not detect a significant effect of gender on word recall, F (1,58) = 3.943, p = .052. $\eta^2 = .041$, an observed power of .497 was noted, and so this hypothesis failed to reject the null. The 2 x 2 x 2 mixed ANOVA also revealed a significantly larger percentage of concrete words recalled in comparison to the percentage of abstract words recalled, F (1,58) = 65.533, $p < .001$, $\eta^2 = .492$ (see Table 1.).

The effect size for gender was notably small (η^2 = .041) compared with that of the very large effect size of group on word recall (η^2 = .449) and the within-subject comparison of concreteness (η^2 = .24). This may have been affected by the ideal number of participants sought out at the recruitment phase of the experiment. A target sample of approximately 65 to 70 participants following a power analysis of Cohen's d, a power primer (1992) was the primary guide for effect size.

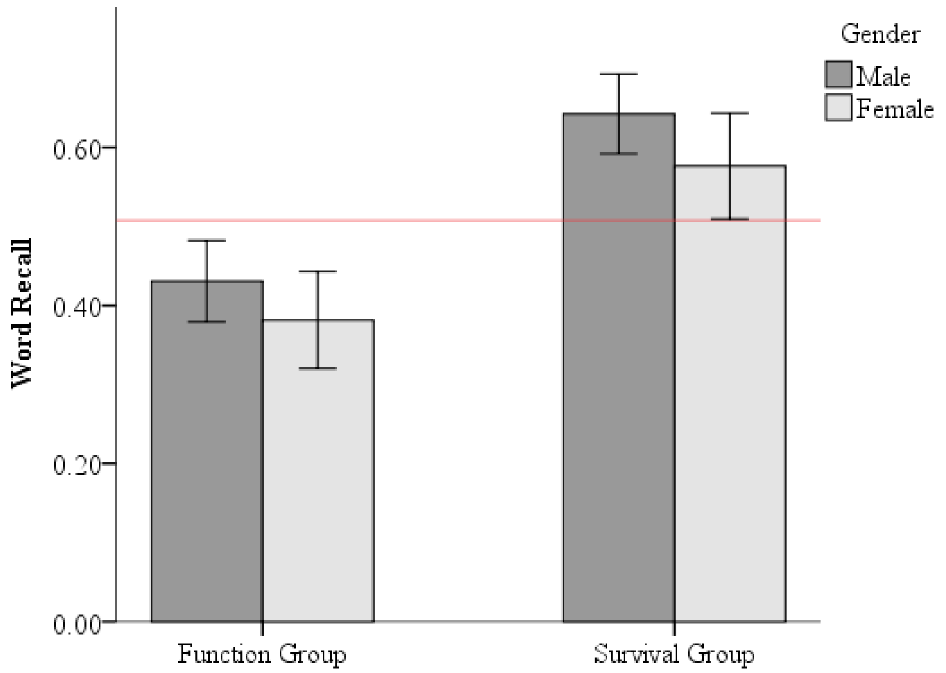

Figure 1. Words recalled (percentage) from a functional encoding focus and novel survival encoding focus. There was a significant effect on word recall from survival encoding, $F(1, 58) = 49.229$, $p < .000$, $\eta^2 = .449$, but no main effects could be seen from gender on word recall, $F(1,58) = 3.943$, $p = 0.52$. $\eta^2 = .041$. *$p = .05$, one tailed. Reference bar indicates the mean (0.5).Error Bars: 95% CI.

It is also worth reporting that there were significant interactions identified between group, gender and concreteness of words recalled, F (1,58) = 5.568, p = .022, η^2 = .041 (see Figures 2 & 3). Two interaction effects were found with males. Results revealed that males in the novel-survival group recalled more concrete, F (1,58) = 8.471, p = .05, η^2 = .03, and abstract, F (1,58) = 15.862, $p < .001$, $\eta^2 = .05$, words in comparison to males in the functional group. Similarly, women in the novel-survival group recalled significantly more concrete words than women in the functional group, F (1,58) = 31.195, p < 001, $\eta^2 = .11$. No difference was found for female participants in the abstract word recall, F (1,58) = 2.998, p = .089, $\eta^2 = .009$, observed power of .39. Interestingly, there were no interaction effects found between group and gender, F (1,58) = .083, $p = 0.775$. $\eta^2 = .001$, observed power of .059. The earlier finding in this experiment that recall was not affected by gender, shows us that this significant effect must lie in the interaction between group, gender and concreteness.

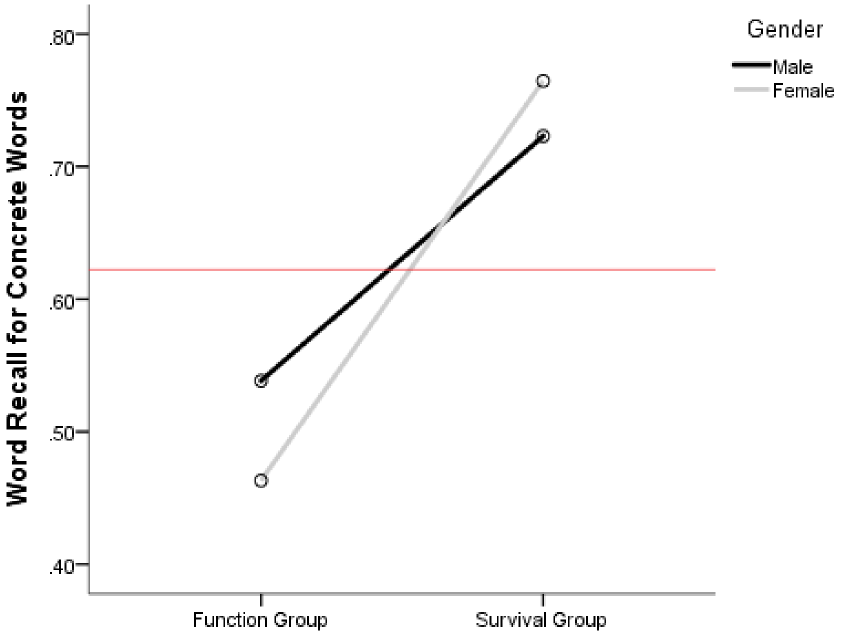

Figure 2. Rate of concrete words recalled (percentage) in terms of gender from a functional encoding focus and novel survival encoding focus. Males in the novel-survival group recalled more concrete words than males in the functional group $F(1,58) = 8.471$, $p = .05$, $\eta 2 = .03$. Females in the novel-survival group also recalled more words than their functional group counterparts $F(1,58) = 31.195$, $p < 001$, $\eta 2 = .11$ one tailed. Reference bar indicates the mean (0.62).

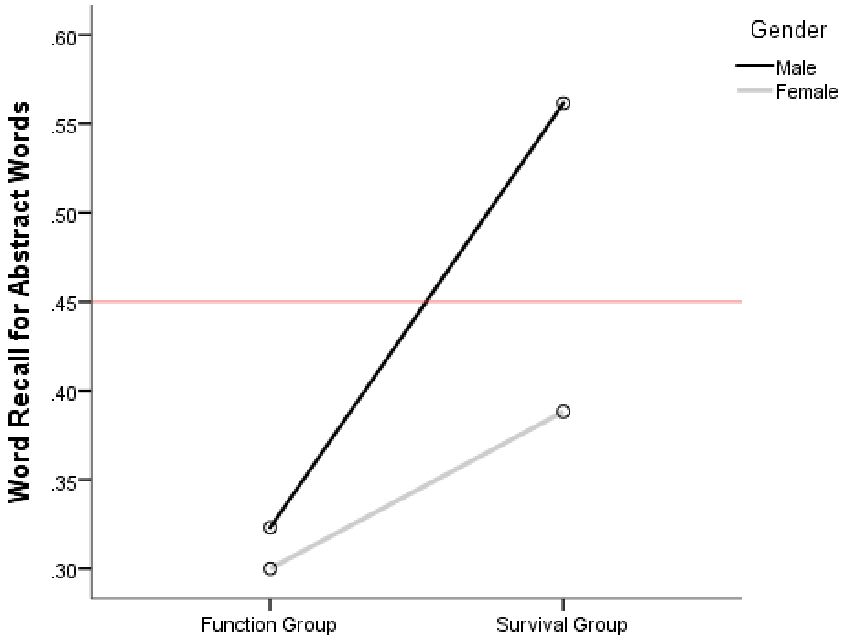

Figure 3. Rate of abstract words recalled (percentage) in terms of gender from a functional encoding focus and novel survival encoding focus. Males in the novel-survival group recalled more abstract words than males in the functional group $F(1,58) = 15.862$, $p < .001$, $\eta 2 = .05$, one tailed. Reference bar indicates the mean (0.45).

A Pearson's correlation was used to assess the relationship between the independent variable (age) and the dependent variable (word recall). As predicted, the test confirmed that there was no correlation between these two variables, $r = .044$, $n = 62$, $p = .735$ (See Figure 4). Even though this result was expected, it should be brought to the attention of the reader that the effect size was severely low for this variable.

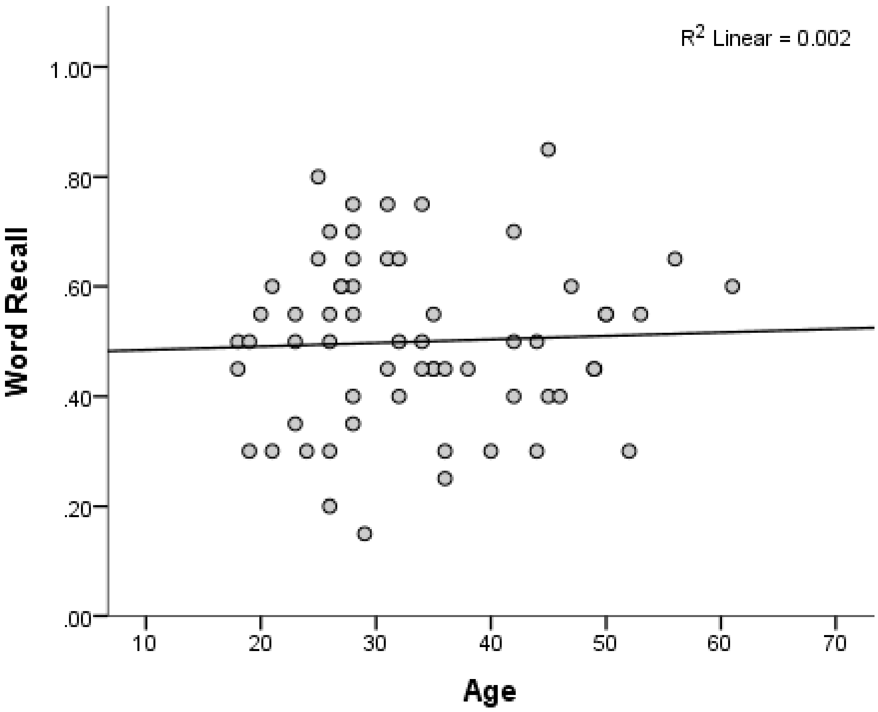

Figure 4. Scatterplot indicating the percentage of words recalled and it's relationship to age. In this experiment, no significant correlation was found between these two variables, r = 0.44, n = 62, p = .735. *p = .05, two tailed.

Discussion

Mechanisms of Survival-Processing, the Significant Effects of Encoding Strategies

The central hypothesis of this study was that a novel-survival encoding context would have a significant effect on word recall compared to a functional-thinking encoding context. We found that this hypothesis was confirmed as participants in the novel-survival group had a higher rate of recall than those in the functional encoding group (see Figure 1.). This result was backed up by a large sample size relative to the effect measured in this condition. Although this result was anticipated, the considerable difference can be inferred to mean a greater number of cognitive mechanisms were involved in this encoding strategy.

Novel-survival encoding had previously surpassed its forerunner, survival encoding (Sodertrom & McCabe; 2011), which by its own merit outmatched a number of other eminent memory techniques (Nairne et al., 2008). We can postulate that novel-survival encoding must therefore operate with some, if not all, of the various factors associated with recall: elaborate encoding, distinctiveness, context and depth of processing (Anderson, 1994; Shepherd, Gibling & Ellis,1991; Craik & Lockhart., 1972). Furthermore, novel-survival encoding is likely to be a partially, if not mostly, domain-specific form of cognition as it seems to be activated by distinct instructions or prompting (Nairne & Pandeirada, 2008). A memory system which, when active, could discriminate vital from superfluous information would be highly advantageous for survival.

Processing information in this way could allow an individual to intentionally trigger reactivation of the original neural pathway with relative ease in comparison to thinking about information in a functional context exclusively (see Sodertrom & McCabe, 2011; Bell et al., 2015; Nyberg, 2002). Considering selection pressures in terms of survival and spatial navigation, it could be possible that attention to novel stimuli in the environment for hunting or gathering food, avoiding predators and remembering social group information was selected for in biological memory systems (Buss, 2014). These necessities would have been vital for survival, and memory systems functioning in this way would have improved an individual's fitness (Weinstein et al., 2008)

The current study is novel in that we identified a gap where the quantitative differences of functional-based mechanisms to novel-survival encoding needed to be measured (e.g., Bell et al., 2015; Nairne & Pandeirada, 2008; Nairne, 2005). Assuming that a functional-thinking mechanism was a characteristic of survival-processing, Bell et al. (2015) wisely measured functional encoding against threat to investigate negative arousal incited in survival-processing. Functional encoding seems to produce particularly elaborate encoding by implementing idiosyncratically interactive visualizations about a word or concept with the individual user. This additionally suggests that a functional form of encoding favours concrete words as they are easier to relate to real-world concepts (Barber et al., 2013; Fliessbach et al., 2006). However, a similar interaction may also be involved with novel-survival encoding, which also utilizes a number of other processes.

What we propose is that functional encoding is one component of the survival-processing effect. It seems probable that a functional-based mechanism may covertly operate within novel-survival encoding based on our findings. Future studies should aim to confirm this hypothesis by conducting recall experiments consisting of two survival-processing encoding strategies, each emphasizing an opposing focus: interaction versus inaction. Addition or removal of the novelty effect in future studies could prove essential depending on the objectives of the researcher. Supplementing functional encoding with a novelty aspect and measuring it against survival encoding may perhaps permit a more detailed examination of these encoding strategies in diverse permutations.

Word Type, Interaction Effects and the Functional-Thinking Hypothesis

The second hypothesis of this study was that word type would significantly affect recall. Specifically, we predicted that concrete words would have a higher rate of recall than abstract words. That is precisely what was discovered in our results. More concrete words were recalled than abstract words across all conditions (see Table 2.) This is consistent with other literature (Bell et al., 2015; Chiarello et al. 1987), confirming that word type, specifically concreteness of words, influences the rate at which those words are recalled in memory experiments. Unlike our first hypothesis, these results are not novel nor are they surprising. However, when conducting recall experiments, especially in terms of evolved psychological mechanisms of memory, it is essentially to split word type into these two categories (Chiarello et al., 1987). Reasoning for this is clear when we consider how language plays a significant role in our cognition (Boroditsky, 2011). Concrete words are can be directly related to real-world concepts and stimuli (Barber et al., 2013; Fliessbach et al., 2006).

One of the most interesting findings that we found however, was multiple, complex interaction effects between word type, group and gender. This was particularly fascinating as there were no significant interaction effects found between word type and group, word type and gender, nor group and gender (see Table 2., Figure 2. & Figure 3.). From interpretation of the results, it seems that the novel-survival encoding was responsible for a higher recall rate of both concrete and abstract word in males within the novel-survival group in contrast to the functional group. Captivatingly, we also recorded rise in recall of concrete words of females in the novel-survival group compared to the functional encoding group (Figure 2.). Abstract words in females did not differ across group conditions (Figure 3.).

The information in this study suggests the novel-survival context has a direct effect on both overall recall (concrete and abstract words) in males and concrete word recall in females (Figure 2 & 3.). Our results confirm the discoveries of previous experimental findings (Lippa et al., 2009; Eals & Silverman, 1994) in relation to memory and spatial navigation. These studies display examples of male participants who exhibited a greater memory for abstract concepts, while female participants, subject to the same conditions, had shown a tendency to notice and remember concrete objects and landmarks in the environment. As stated previously, both encoding strategies used in the current study could utilize mechanisms which encourage the semantic properties of objects to be emphasized. As a result, a distinct and elaborate form of encoding would follow (Bell et al., 2015). In contrast, abstract words have no such affordances as they seem to only be linked to real-world phenomena indirectly (Barber et al., 2013; Fliessbach et al., 2006; Chiarello et al., 1987).

Future research should focus on this word type condition in greater detail which was not possible in the current study. In particular, interaction effects would be of special importance as they not only suggest a complicated relationship between word type and gender, but do so only within certain encoding context parameters which have been implemented in this study. We suggest that any confirmatory experiments concentrate specifically on the relationship between functional-thinking encoding strategies and varying degrees of concrete concepts. One method of doing so would involve assigning a functional visualisation context to a list of words which consist of three word types: concrete, abstract and concrete-abstract pairings (for example “custard-mission”). Measuring the extent of word type on recall in this way would imply that a functional mechanism may be concerned in cognitive processing of concrete information.

The Possible Negation of Gender-Based Memory Advantages

At the beginning of this study, it was stated that gender was a key variable which any research concerning word recall should consider, especially in the light of evolutionary theory (Buss, 2014; Silverman & Phillips, 1998). We hypothesized that females would recall more words than males in the recall task based on other research and theoretical assumptions in the scientific literature (Horgan, 2004; Loftus, Babaji, Schooler & Foster, 1987; Eals, & Silverman, 1994). Surprisingly, we found that this was not the case. Results indicate that there was no significant effect of gender on recall. The distinct difference lay in an interpretation of the interaction effects found between group, word type and gender which was discussed in the previous section.

Finding no significant effect between these variables is noteworthy here as this would challenge certain ideas about memory abilities seen to be influenced by gender (Baron-Cohen et al., 2013). It may be worth considering that gender has only specific impacts on exclusive types of memory systems in humans, for example autobiographical information, names, faces and flashbulb memories (Cohen, Conway & Maylor, 1994; Morse, Woodward, & Zweigenhaft, 1993). A second explanation, and relevant to the current study, would be that encoding contexts in this experiment negate gender-related advantages in the word recall task. This would suggest that mechanisms of both the encoding strategies in the current study have the capacity to annul memory benefits related to gender. An effect of this kind would be strikingly similar to those seen in the cancellation of age-related deficits on memory brought on by encoding strategies (Jacques & Cabeza, 2009, Greenwood, 2000). Presently we can only identify this trend in our data and speculate on this finding. Strong assumptions should be held in humble regard as our sample size, while large in regards to other conditions (group, word type) was too small for to detect any small effects of gender on word recall.

Future research may wish to consider examining the effects of gender on recall by isolating males and females to separate groups and presenting them with survival-themed words. Furthermore, if encoding contexts are indeed responsible for this occurrence we would expect to see similar results to this current finding in our own study. Due to limitations in this study, a larger sample size was not possible to detect a smaller effect. More participants are recommended for forthcoming research concerned with the interaction effects of encoding focus on gender-based advantages which are assumed to impact recall.

Negation of Age-Related Deficits on Memory, Encoding Strategies as an Exaptation

Although age is last to be mentioned in our variables, it is of no less importance as memory loss and cell death in the neocortex are related to this factor. (Raz, 2000; Grady et al.,1995). The final hypothesis in this study was that overall encoding strategies would remove any age-related deficits that may negatively impact word recall. In other words, we made a directional hypothesis that there would be no effect of age on word recall. This premise was based on previous findings (Langenecker & Nelson, 2003; Van der Linden, 2000; Rahhal & Hasher, 1998; Grady et al.,1995). This hypothesis was confirmed as there was no correlation detected between age and word recall (see Figure 4.).

The findings in this study are not novel, but they do emphasize the powerful effect of visualisation strategies used in these experiments and draw attention to survival-processing. Simple instructions prior to a list of words change how those words are processed and stored in long-term memory (Boroditsky, 2011 Rahhal et al., 1998; Salthouse et al., 1991). Although throughout this study we have frequently referred to survival-processing as an adaptation, in the light of memory enhancement and evolution theory, we can regard usage of encoding strategies as a shift in purpose of an evolved psychological mechanism. In this way a survival-tuned memory system could be seen as both mental adaptation and exaptation (Gould & Vrba, 1982).

We must note that, like the gender condition discussed in the previous section, the age and recall condition had low power and effect size. Therefore, although our results have important implications, assumptions made here about the effects of encoding on age would benefit from further investigations with a larger number of participants to detect a smaller effect. Further studies should aim to recruit a larger sample size, and a diverse range of participants with varying age to measure for small effects and trends in the data.

Strengths and Limitations of the Current Study

The strengths of the current study mostly lie in the setting out, and completion of specific goals. First, we attempted to identify and fill an existing gap in adaptive memory research concerned with the comparison of the extent to which functional-thinking contributes to the survival-processing effect (see Bell et al., 2015; Nairne et al., 2008). Then, by accomplishing this, we endeavoured to explore deeper into the proximate mechanisms of adaptive memory. The latter is primarily a concern for research occupied with discovering the ultimate cause of human memory. With the previous things considered, the current study successfully contributed to past and future research in the area of adaptive memory.

Although the methods and word list utilized in the current experiment are not entirely new (e.g., Bell et al, 2015; Nairne et al., 2008), they were a necessity to meet our requirements of recording new evidence and data, exclusively generated within this study. The findings and syntheses made here consider aspects not fully investigated in other literature (Bell et al., 2015; Kostic, McFarland & Cleary, 2012; Nairne, 2005) and are therefore novel. Our research can also be considered cross-disciplinary as we have investigated and discussed within the parameters of various scientific fields; these were namely cognitive psychology, neuroscience and evolutionary psychology. Investigative methods were here utilized in what would otherwise be considered an evolutionary psychology venture, a field which is mostly deemed speculative (Buss, 2014, Dunbar, 2003; Johnson,1992).

Within the central hypothesis testing (encoding focus/ groups), we detected a large effect size with a large sample size. This was also true with regard to word type (concrete, abstract words). The gender-recall and age-recall conditions displayed small effect sizes and no significant effect could be found; the former hypothesis was refuted, while the latter (a directional hypothesis) was confirmed. Perhaps a small effect could have been detected with a larger sample size. However, this was not possible as we did not have access to more participants. Another limitation was the selection procedure of participants. A convenience sample had to be used. This is unfortunate as a systematic random sampling approach would have been preferred but was unrealistic for this study.

Anticipating the reader's analysis, we must point out one particular feature within the study which may have already been noticed. The current study did not use a control group for comparison with our experimental groups. Three important reasons for this must be identified: 1) doing so would have required a larger sample size of which we could not avail, 2) previous adaptive memory studies (e.g., Nairne, Pandeirada, Gregory & Arsdall, 2009) have before confirmed the effectiveness of these encoding strategies against control groups in terms of word recall, and 3) doing so would have exhausted participants from our experimental groups, which were concerned with measuring key differences of effective encoding strategies. Overall, the current study had some limitations; however, considering the hypotheses being tested, these were controlled for as best possible.

Implications of the Current Study, the Utilization of Adaptive Memory Research

Throughout our discussion we have touched on various implications that our findings may have on future scientific research into further investigations of adaptive memory. Nevertheless, these do not cover the knock on effect of the theoretical and practical applications to the scientific literature and field. Identifying proximate mechanisms within evolved psychological adaptations such as memory, allow researchers to then manipulate conditions so as to measure to what extent each component piece operates within that system (e.g., Eals & Silverman, 1994). Adaptive memory must be somewhat domain specific and corresponds to the problems that humans needed to solve in the environment (Nairne et al., 2008). As such, we can presume, with some accuracy, which mechanisms must be activated as part of novel-survival encoding.

One of these has been the focus of our investigations, functional-thinking (or encoding), is a possible component of novel-survival encoding. Both exhibit elaborate encoding and highlight the semantic properties of objects in the environment. Comprehending the proximate causes of adaptive memory permits researchers to expand into the other three of Tinbergen's (1951) questions which need to be contemplated; the phylogenetic, ontogenetic and ultimate cause of human memory. The current study slightly expanded on these questions. For example, an individual implementing (or teaching) a novel-survival encoding strategy can be said to be contributing to ontogenetic development and cause of a mnemonic strategy as it has the potential to improve the fitness of an individual (Buss, 2014; Dunbar, 2003). Consequently, that person can influence the environment and a feedback loop is cultivated, also known as niche construction (Laland, 2006).

The same can be said of the type of words used in education systems and memory loss prevention. If concrete words are better remembered, then usage of those words should be recommended for training programmes of all variations. Abstract concepts would benefit from being linked to concrete concepts and these pairings could be implemented in day-to-day scenarios and education systems to improve human memory systems. This is particularly important in age-related memory loss. Cell death in the neocortex certainly does contribute to memory loss (Raz, 2000) but the main factors are unsuccessful encoding and lack of neuronal connectivity (Barber et al., 2013; Langenecker & Nelson, 2003). These connections can be improved by making more associations in memory (Bechara, Tranel & Damasio, 2000; Greenwood, 2000). The interaction effects of this study, which we examined in detail, show us that word type, gender and encoding must have a complex relationship that remains to be fully explored. It is the responsibility to investigate this phenomenon in greater detail.

Gender-based memory advantages are useful to consider in evolutionary theory because they allow ideas to be formulated as to their evolutionary purpose (Eals & Silverman, 1994; Lippa, Collaer & Peters, 2009). Even though our study did not detect any such advantages, the results are still of interest. The fact that gender had no impact on word recall suggests that encoding contexts actually may cancel out these advantages if they exist, or that a specialized memory system available to a specific gender do not extend to semantic memory.

A specialized memory system which has evolved to meet the requirements of specific environmental demands can be popularly contrasted to that of a computer programmed for a particular purpose (Wood, Baxter & Belpaeme 2012; Nairne et al., 2008). Although the computer analogy provides us with a good model in which to study biological memory, it is not quite accurate (Fabiani & Donchin, 1995). There are a number of key differences which are only now being understood in light of modern research. Computers can complete large sums of numbers at an extremely fast rate whereas biological brains are efficient at decoding sensory information and making inferences (Wood, Baxter & Belpaeme 2012). Machines function in a cascade manner by completing tasks in a serial fashion. Compare this to a biological brain and we see that synapses operate entirely in parallel and without specific programming (Wilson, Darling & Sykes, 2011). In computer memory a piece of data is literally stored at an address and when the memory wants to be recalled, the address is accessed and that exact patterns of binary code is moved to a buffer.

Optimization of biological memory, much like that of programming a computer, involves understanding how best it functions and utilizing the mechanisms so as it can operate at optimal efficiency (Fabiani & Donchin, 1995). Recognition and use of distinctive qualities, context, elaborate encoding and depth of processing can all be employed in this way with an effective mnemonic strategy to increase the encoding, storage and retrieval of memories (Gilboa, Alain, Stuss & Moscovitch, 2009; Shepherd et al.,1991; Craik & Lockhart., 1972). A memory system that demands the filtering of vital from superfluous information would be required to make use of these important factors (Cohen & Conway, 2007; Sherry, & Schacter, 1987). Survival-processing, especially novel-survival encoding, appears to meet these requirements. The mechanisms operating in these fitness-content parameters seem to exist because they improve the fitness of organisms. (Buss, 2014, Dunbar, 2003). Promisingly, humans now have the potential to divert the function of survival-processing for utilization as a tool for memory enhancement, making an encoding strategy a psychological exaptation.

Conclusion

The current study set out to investigate the proximate mechanisms of adaptive memory by focusing on the measurable difference between functional and novel-survival encoding. Adaptive memory research has concerned itself on the survival-processing effect which has been suggested to be domain-specific and concerns itself with solving particular problems in the organism's environment. Our hypotheses were designed to examine these assumptions.

The central hypothesis for this study was confirmed as novel-survival encoding had a significant effect on word recall compared to functional encoding. Next, word type (concreteness) significantly impacted recall and was our main point for opening discussions on the significant interactions effects found between group, word type and gender. Third, we unexpectedly found no effects between gender and word recall. Lastly, no significant effects could be detected between age and word recall which confirms our directional hypothesis.

The human mind is a complex amalgamation of mental adaptations that have adapted to suit the requirements of a complicated environment (Nairne et al, 2008). Our memory systems are not perfect but have the potential to operate beyond expectations when activated in the appropriate circumstances. Increasingly, we outsource cognitive resources to machines without a second thought to the consequences (Cohen & Conway, 2007). Yet, research has shown us that biological memory also has a capacity to categorize and filter data once it has distinguished information as important (Fabiani, & Donchin, 1995; Johnson, 1992). Memory has adapted in this manner in order to solve specific problems within the environment in which it evolved (Buss, 2014). To maximize efficiency in the human memory, we must continue to investigate the conditions our memory systems are adapted to and the proximate mechanisms available at their disposal. It is the responsibility of researchers to indicate potential benefits of encoding strategies and recommend them where they are needed.

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Appendix A

Forms used in the study

Word visualization Experiment

My name is Paul and I am conducting a psychological experiment investigating an area of research in evolutionary psychology which involves mental adaptations in imagination and word visualization. This research is being conducted as part of my studies and will be submitted for examination.

You are invited to take part in this study and participation involves completing three sheets containing different tasks and then returning the attached anonymous sheets. The overall time of the experiment will run between 15 to 20 minutes.

While these tasks ask you to visualize specific scenarios they may cause some minor negative feelings. If any of the questions do raise difficult feelings for you, my contact information is included below.

Participation is completely voluntary and so you are not obliged to take part.
Participation is anonymous and confidential.

Task sheets will be securely stored and data from these will be transferred from the paper record to electronic format and stored on a password protected computer.

Should you require any further information about the research, please contact me. The consent form can be found with this sheet. Please fill this out before taking part in the experiment.

Paul Mooney,

Email: xxxxxx@xxxxx
Phone number: 000 000000.

Appendix A

Forms used in the study

Consent Form

Word visualization Experiment

I have read and understood the attached Information Leaflet regarding this study. I have had the opportunity to ask questions and discuss the study with the researcher and I have received satisfactory answers to all my questions

I understand that I am free to withdraw from the study at any time without giving a reason and without this affecting my training

I agree to take part in the study

Participant's Signature: ______________________________

Participant's name in print: _________________________

Date: _________

Appendix A

Forms used in the study

Experiment Debriefing

At the beginning of the experiment you were asked to visualize words and rate them according to the level of detail you experienced with the mental imagery of each word. However, the true aim of this experiment was to measure recall after specific instructions. One group was asked to visualize words using a functional focus (using or interacting with the word or concept) while another group was asked to conjure mental imagery with the same words in terms of a survival situation (zombie apocalypse). The purpose of these setups is to isolate the mechanisms of memory into functional and survival encoding respectively to investigate the purpose of memory from an evolutionary perspective.

Recent research in evolutionary psychology has focused on memory as a mental adaption in humans, which has aided survival and group cohesion. It is the hope that the data from this experiment will contribute to the growing knowledge about the origins, development and function of human memory.

Thank you for your participation

Paul Mooney

Appendix B

Task sheets used in the study

Age: __________

Gender: __________

Task instructions

Using your imagination please visualise yourself personally interacting and/ or using the following list of words or concepts. Create mental imagery for each of these words and rate them according to the detail of each image.

Do this with the following steps:

4. After reading a word, close your eyes and visualise the word in the above context.
5. Create a mental image and imagine interacting with/ personally using that image.
6. Rate the word by circling a number based on the level of detail you can imagine for the word.

	No Detail	Low Detail	Medium Detail	High Detail	Perfect Detail
Subway	0	1	2	3	4
Lettuce	0	1	2	3	4
Leopard	0	1	2	3	4
Missile	0	1	2	3	4
Pocket	0	1	2	3	4
Giraffe	0	1	2	3	4
Elbow	0	1	2	3	4
Harbour	0	1	2	3	4
Custard	0	1	2	3	4
Wagon	0	1	2	3	4
Treason	0	1	2	3	4
Expanse	0	1	2	3	4
Leader	0	1	2	3	4
Rumour	0	1	2	3	4
Magic	0	1	2	3	4
Carnage	0	1	2	3	4
Lesson	0	1	2	3	4
Combat	0	1	2	3	4
Mission	0	1	2	3	4
Decade	0	1	2	3	4

Appendix B

Task sheets used in the study

Age: __________

Gender: __________

Task instructions

Using your imagination please visualise yourself in a zombie apocalypse and you are faced with the following list of words or concepts. Create mental imagery for each of these words and rate them according to the detail of each image.

Do this with the following steps:

1. After reading a word, close your eyes and visualise the word in the above context.
2. Create a mental image and imagine interacting with that image in a zombie setting.
3. Rate the word by circling a number based on the level of detail you can imagine for the word.

	No Detail	Low Detail	Medium Detail	High Detail	Perfect Detail
Subway	0	1	2	3	4
Lettuce	0	1	2	3	4
Leopard	0	1	2	3	4
Missile	0	1	2	3	4
Pocket	0	1	2	3	4
Giraffe	0	1	2	3	4
Elbow	0	1	2	3	4
Harbour	0	1	2	3	4
Custard	0	1	2	3	4
Wagon	0	1	2	3	4
Treason	0	1	2	3	4
Expanse	0	1	2	3	4
Leader	0	1	2	3	4
Rumour	0	1	2	3	4
Magic	0	1	2	3	4
Carnage	0	1	2	3	4
Lesson	0	1	2	3	4
Combat	0	1	2	3	4
Mission	0	1	2	3	4
Decade	0	1	2	3	4

Appendix B

Task sheets used in the study

Task 2 Instructions

Please do your best to complete the following math problems within 5 minutes.
Use the space below to work out the questions.

A. 5124 + 2144 – 3784211

B. 201 x 3429754 x 3

C. (x - 2) (3x + 9) / (662 + 5x)

Appendix B

Task sheets used in the study

Task 3 Instructions

In part 1 you were asked to create imagery for a list of words. You must now try to recall that list of words within 5 minutes. Use the following spaces below to write down as many of those words as possible. It may help to close your eyes and recreate the imagery from the first task. The spellings of the words are not important.

Appendix C

Tables and Figures used in the study

Table 1.

Instructions Used in the Visualization Task to Emphasize Encoding Focus in Groups

Encoding Focus	Instructions
Functional	Using your imagination please visualize yourself personally interacting and/ or using the following list of words or concepts. Create mental imagery for each of these words and rate them according to the detail of each image. Do this with the following steps: 7. After reading a word, close your eyes and visualize the word in the above context. 8. Create a mental image and imagine interacting with/ personally using that image. 9. Rate the word by circling a number based on the level of detail you can imagine for the word.
Novel-Survival	Using your imagination please visualize yourself in a zombie apocalypse and you are faced with the following list of words or concepts. Create mental imagery for each of these words and rate them according to the detail of each image. Do this with the following steps: 4. After reading a word, close your eyes and visualize the word in the above context. 5. Create a mental image and imagine interacting with that image in a zombie setting. 6. Rate the word by circling a number based on the level of detail you can imagine for the word.

Note. Words that differed between each group are in italics.

Appendix C

Tables and Figures used in the study

Table 2.

Mean score for words recalled between encoding focus, gender and word type

	Functional				Novel-Survival			
	Male		Female		Male		Female	
Word type	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Concrete	.54	.18	.46	.16	.72	.12	.76	.18
Abstract	.32	.16	.30	.16	.56	.16	.39	.13
Total	.43	.09	.38	.13	.64	.08	.58	.13

Appendix C

Tables and Figures used in the study

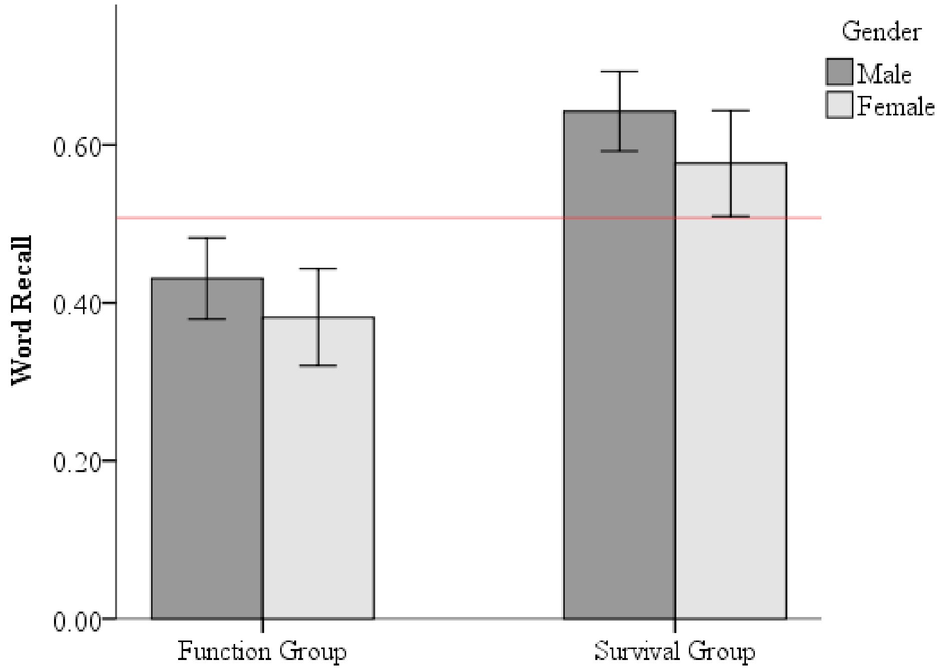

Figure 1. Words recalled (percentage) from a functional encoding focus and novel survival encoding focus. There was a significant effect on word recall from survival encoding, $F(1, 58) = 49.229$, $p < .000$, $\eta 2 = .449$, but no main effects could be seen from gender on word recall, $F(1,58) = 3.943$, $p = 0.52$. $\eta 2 = .041$. *$p = .05$, one tailed. Reference bar indicates the mean (0.5).Error Bars: 95% CI.

Appendix C

Tables and Figures used in the study

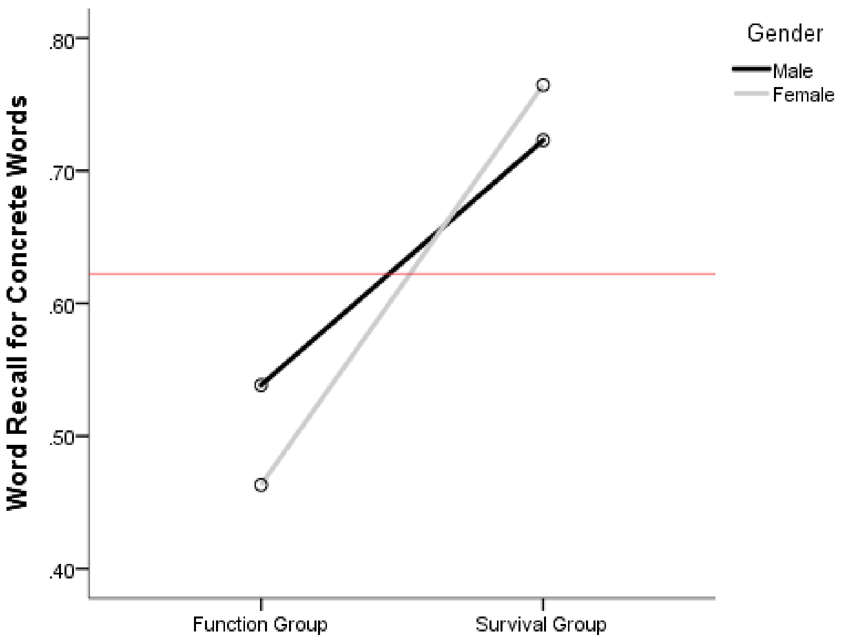

Figure 2. Rate of concrete words recalled (percentage) in terms of gender from a functional encoding focus and novel survival encoding focus. Males in the novel-survival group recalled more concrete words than males in the functional group $F(1,58) = 8.471$, $p = .05$, $\eta 2 = .03$. Females in the novel-survival group also recalled more words than their functional group counterparts $F(1,58) = 31.195$, $p < 001$, $\eta 2 = .11$ one tailed. Reference bar indicates the mean (0.62).

Appendix C

Tables and Figures used in the study

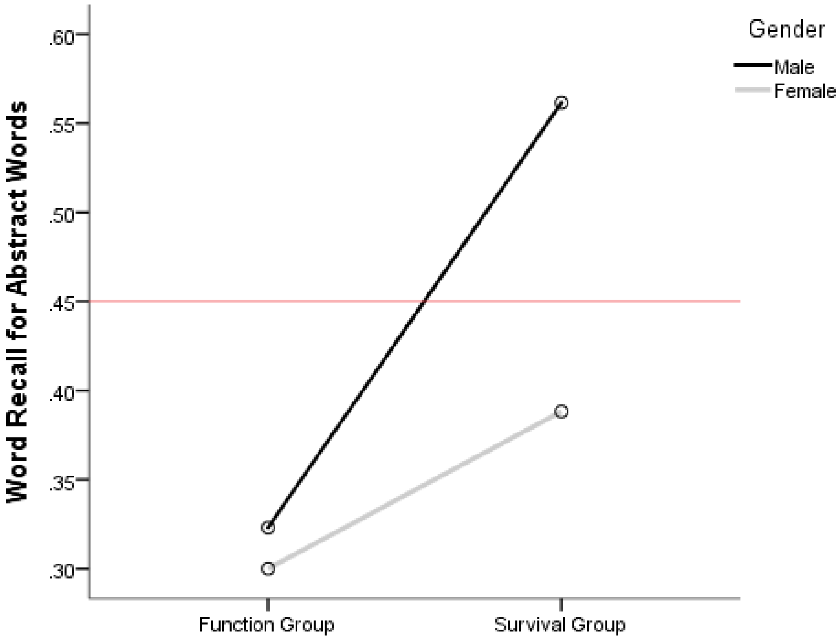

Figure 3. Rate of abstract words recalled (percentage) in terms of gender from a functional encoding focus and novel survival encoding focus. Males in the novel-survival group recalled more abstract words than males in the functional group $F(1,58) = 15.862$, $p < .001$, $\eta 2 = .05$, one tailed. Reference bar indicates the mean (0.45).

Appendix C

Tables and Figures used in the study

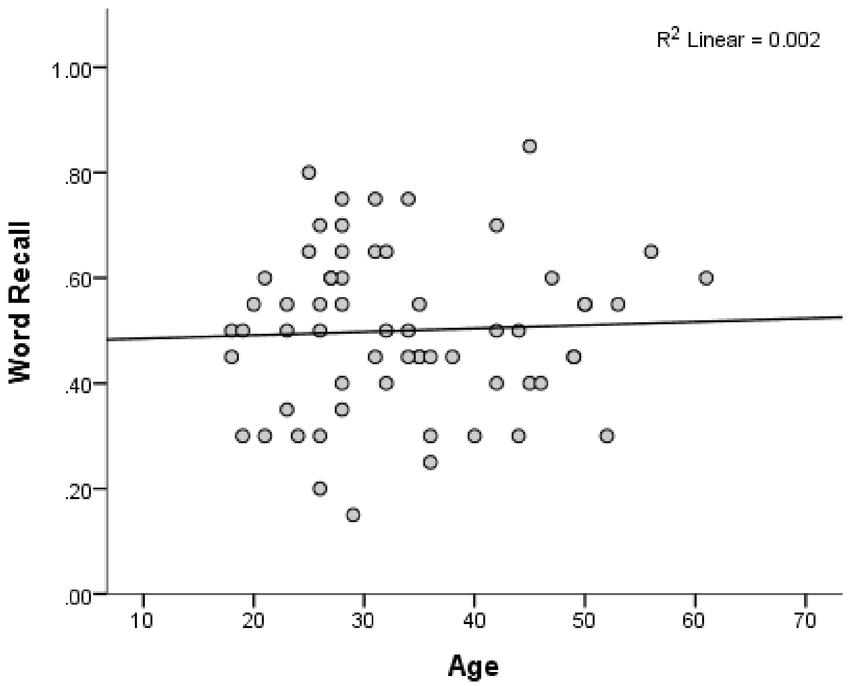

Figure 4. Scatterplot indicating the percentage of words recalled and it's relationship to age. In this experiment, no significant correlation was found between these two variables, r = 0.44, n = 62, p = .735. *p = .05, two tailed.