6-2011

The effects of Death Priming and Survival Processing on Retention

Stephane Boileau
Union College - Schenectady, NY

The effects of Death Priming and Survival Processing on Retention

By

Stéphane Boileau

****

Submitted in partial fulfillment

of the requirements for

Honors in the Department of Psychology

UNION COLLEGE

June, 2011

Abstract

BOILEAU, STEPHANE The effects of Death Priming and Survival Processing on Retention. Department of Psychology, June 2011.

ADVISOR: Dr. Daniel Burns

In 2007, J.S Nairne, S.R Thompson and J. N. S. Pandeirada investigated the idea that memory systems might have evolved in order to help us remember fitness-relevant information, especially relevant to our own survival. They showed that retention of words rated for their relevance to survival is superior to any other deep processing condition like pleasantness, imagery, self-referential processing, and so on. Since then, many experiments have investigated this "survival processing" effect. Recently, a retention benefit for subjects being primed about thinking of their own death has also been found (Hart & Burns, 2011). I present an experiment that looks at the effect of a combination of survival processing and death priming to determine if they are both caused by the same mechanism or if they are two completely different entities acting to benefit retention. The experiment consisted of subjects rating a list of words for their relevance to survival (or pleasantness) after answering a questionnaire about death or dental pain. I was able to recreate the survival processing effect and the mortality salience effect separately. Results also suggest that the mortality salience effect is due to an increase in item-specific processing. Lastly, when the two processes were combined, no additional retention beyond that produced by survival processing alone was found, suggesting that the mortality salience effect might be a component of the survival processing effect.

Introduction

In 1859, Charles Darwin introduced the notion of natural selection which stipulates that the organism more "fit" to its environment has a better chance of surviving and passing its genes to the next generation compared to the ones lacking those traits. Therefore, changes in the environment tend to select these individual organisms that possess specific genetic traits, giving them phenotypical advantages which increase their survival and reproductive rates over other organisms of the same species (Latta, 2010). The discovery of penicillin in 1928 is a good example illustrating natural selection in many bacterial species. During the Second World War, penicillin was the most widely used antibiotic to prevent infection for wounded soldiers. The antibiotic was able to kill almost all kinds of bacteria. However, over the years, genetic changes in some bacteria gave them resistance and allowed them to grow in the presence of penicillin. These organisms were surviving and passing their genes to later generations and over time, all the organisms from this species were resistant. Because of natural selection, today about 70% of bacteria are resistant to at least one of the most commonly used drugs for treatment (Todar, 2011).

Advantageous traits tend to become more common in the next generations if they can be transferred. Many other examples have been found in all kind of organisms, from unicellular, to bacteria, to plants and animals. Humans are no exception to natural selection and fitness. If we go back 20,000 years ago, humans were living in dangerous and hazardous environments where surviving was a daily routine. They needed to find food, water, build a shelter, and protect themselves from predators. Therefore, the ones more "fit" in these exposed environments had more chances to reproduce and pass their genes to the next generation. For many years, scientists have looked at physical qualities that these humans had in order to survive. However, lately, psychologists and neuroscientists have looked at the mental and cognitive adaptations that have evolved from the past. One type of cognitive adaptation, the one on which this paper

focuses, is adaptive memory. It is defined as the mechanisms that have evolved from the past and that are involved in memory systems to facilitate survival and reproduction (Anderson & Schooler, 1991).

In 2007, Nairne, Thompson and Pandeirada addressed this notion of adaptive memory that shaped our memory systems over time. They reasoned that our memory systems evolved to help us survive, and therefore, may be adapted to remember survival-relevant information. They proposed that processing material, like a list of words, in terms of their relevance to survival should improve retention. In order to test their hypothesis, they compared a task focusing on survival to control conditions known to promote deep and semantic processing but unrelated to survival. In their experiment, they first used a pleasantness rating task as a control group since this task was already known to be one of the best ways to improve retention. They also added a moving scenario in order to induce significant self-referential processing similar to the survival scenario. In the survival task, participants were asked to imagine themselves being stranded in the grasslands of a foreign land without any basic supplies and were asked to rate words in terms of their survival relevance. After a short period of distraction, unexpected recall or recognition of the list of words was tested. Their results showed a clear mnemonic advantage for survival processing despite the fact that the two other rating conditions produced a deep level of processing. Additionally, their analysis ruled out the possibility that this retention benefit was due to differences in the numerical ratings of the words or by the amount of time required to rate the words since, across experiments, neither were consistently significant. Therefore, they proposed that our memory systems might have been tuned to remember information that is relevant to survival.

Since this discovery, the survival orienting task has been compared to a wide variety of control conditions. Nairne, Pandeirada, and Thompson (2008) tested the survival mnemonic advantage by including other encoding techniques that are universally accepted as producing

excellent retention. These included conditions in which participants were asked to rate words for imagery, pleasantness, and self-relevance. Participants also generated words, or studied them with the intention of learning them for a later recall test, or rated words for their relevance to a vacation situation which was contextually rich but not related to survival. The results showed more evidence of the strong mnemonic advantage in survival processing. Making a simple decision about the relevance to an ancestral survival scenario in an unrelated list of words produced significantly better retention relative to all of these standard deep-processing controls. They concluded that survival processing "is one of the best – if not the best – encoding procedures yet identified in human memory research when a free recall test is used" (p.180).

Kang, McDermott, and Cohen (2008) compared the survival scenario to the planning of a bank heist. This new control condition was supposed to be equivalent to the arousal, novelty, and media exposure levels of the survival processing task. Participants were asked to imagine themselves as the leader of a group planning a bank heist and then rated words according to their relevance to this scenario. Again, the survival processing condition produced superior recall and also recognition performance, suggesting that neither novelty, arousal, nor media exposure can explain the significant survival memorial benefit. In another experiment, they tested if the survival processing effect would persist when the concept of the self was removed. To do so, they used video clips from the movie *Cast Away* to recreate the survival condition and scenes from the movie *Inside Man* to reconstruct the burglary condition. Their results demonstrated that the survival processing effect can also be obtained when considering the survival of others. Consequently, an explicit contemplation of one's own survival may not be critical to produce the survival effect.

Interestingly, Otgaar, Smeets, and Van Bergen (2010) examined whether the survival recall advantage also holds for other classes of stimuli, such as pictures. If the survival processing effect results from adaptive mechanisms, processing pictures should also create a

mnemonic benefit since the latter preceded the processing of language in human evolution (Paivio, 2007). Therefore, from an evolutionary standpoint, the survival effect should be larger for pictures than for words. Their experiment replicated the one by Nairne and colleagues (2007), but they used pictures instead of a list of words. The findings showed that the survival recall advantage is also present when pictorial stimuli are used, but pictures do not benefit more from survival processing than do words. However, their results showed that the survival recall effect is a robust and universal phenomenon.

Weinsten, Bugg, and Roediger (2008) suggested that evaluating words for their relevance to the survival scenario may produce greater schematic processing than do conditions such as rating words for pleasantness. This idea might be a reason why survival processing generates significant memory improvements over all the other conditions used in the past. To test this hypothesis, they replicated the effect by comparing the ancestral survival condition to a city survival control condition. The scenarios were designed so that both would produce the same amount of schematic processing. The two scenarios involved were almost identical in wording:

"In this task we would like you to imagine that you are stranded in the grasslands (city) of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators (attackers)"

Only two words were changed in the instructions, grasslands for city, and predators for attackers. Their hypothesis was that the ancestral condition would produce better memory if the human memory systems have been shaped by evolution across many generations. Therefore, according to this hypothesis, dangers that our ancestors faced 20,000 years ago in their environment (grasslands) should still be more salient to us today than the threats we have been facing recently in a more modern environment (city). Their findings supported the evolutionary perspective since the ancestral survival scenario produced higher recall then the modern

survival situation. It discredits the idea that the survival processing effect is due to a difference in the amount of schematic processing since both conditions were nearly identical, and presumably schematically equivalent.

Nairne and Pandeirada (2010, Experiments 2 and 3) also explored other survival problems and compared ancestral and modern scenarios for these problems. In one experiment, participants were told to imagine they had been hurt and a dangerous infection might be developing. Their task was to search for and find relevant medicinal plants in an attempt to cure the infection (ancestral scenario) or to find relevant antibiotics (modern scenario). In the other experiment, they were asked to imagine gaining needed nourishment either by searching for and buying food in a city (modern), or by searching for and gathering edible plants in the grasslands (ancestral). Again, consistent with the evolutionary account, the results of both experiments showed a significant mnemonic advantage for the ancestral survival conditions over the modern scenarios. By remembering fitness-relevant information, like the location of food, the types of predators, or the medicinal properties of certain plants, one's probability of surviving and passing his or her genes to the next generation would likely improve.. Their findings replicated and extended the previous work done by Weinstein et al. (2008).

Klein, Robertson, and Delton (2010) stated that the adaptive function of our memory systems is to support future decisions. They compared recall between a survival orienting task and a set of encoding tasks that differed with respect to their temporal orientation (past, atemporal, and future oriented). All of the participants were asked to imagine being in the woods. The survival-oriented condition was similar to Nairne and Pandeirada's scenario (2007). In the past-oriented condition, the subjects were instructed to recall a specific time in their past when they went camping. In the future-oriented condition, the participants were asked to imagine that they were planning to go camping. Finally, in the atemporal-oriented condition, the subjects were asked to use their generic knowledge of camping to form an image of a campsite.

All participants rated a list of words, all objects, about the likelihood of being at the campsite. Nairne and colleagues (2007, 2008) already included a planning condition, such as planning to move to a new home, in some of their studies. However, Klein and colleagues believed that the superior performance in the survival condition might have been due to large variations in the encoding tasks (survival vs. planning to move) and the context of the encoding (surviving in the grasslands of a foreign land vs. moving to a new home in a foreign land). In their experiment, the context of the encoding was held constant across conditions (being in the woods). Consistent with their predictions, future-oriented planning resulted in better memory than all the other conditions, even the survival condition, although the survival condition was superior to the other conditions. Their results supported the argument that memory systems have evolved to include features about planning for the future, and that when planning is appropriately engaged, memory performance is particularly efficient (Klein et al., 2010). However, they were not able to clearly explain why they obtained a superior recall performance for the future-oriented task over the survival condition. One of the plausible explanations was that the planning task involved more planning than the survival scenario.

Nairne and Pandeirada (2008) also tested the survival effect using a categorized list. In two experiments, one between-subjects and the other within-subjects, participants were asked to make rating decisions about words in an obviously categorized list that were all related to survival (animals, fruits, vegetables, and human dwellings). Data showed that survival processing produced the best recall performance, despite the fact that pleasantness rating of words in a categorized list has long been considered as a “gold standard” (p. 383) for improving free recall performance.

However, Butler, Kang, and Roediger (2009) argued that most survival studies may be confounded with the congruity effects since they used words highly related to survival. Therefore, Butler and colleagues decided to investigate the congruity effect, which refers to the

general finding that items are better remembered when they are congruent with the encoding condition. Similar to Kang et al. (2008), they compared the survival scenario to the bank robbery scenario but used a list of words that was either highly relevant or irrelevant to the two encoding conditions. Their results revealed that when the list was relevant to survival, the survival advantage was still large. However, the effect disappeared when the list was irrelevant to both scenarios, and the bank heist condition actually outperformed the survival scenario when the words were relevant to the robbery scenario only. Therefore, they suggested that when the material is carefully controlled with respect to congruence between type of processing and the list of words, survival processing does not always produce superior recall. These findings support the idea that congruity effects are robust and important phenomena and these data are important since they restrain the generality of the survival processing advantage

The following year, Nairne and Pandeirada (2010) re-investigated the proposal of Butler and colleagues that the congruity effects between target items and processing tasks might explain the memory retention benefits for survival processing. In their experiment, they replicated the results of Butler et al. (2009), using the same encoding conditions while changing some details in the experimental designs. In Experiment 2, instead of having three list of words (highly relevant to survival, highly relevant to robbery, and irrelevant to both scenarios), participants received only words that were irrelevant to their encoding condition (survival or robbery). In Experiment 3, only congruent words for the assigned scenario were used. Finally, in Experiment 4, participants were asked to rate words for their relevance to either the survival or robbery scenario where some of the words were either congruent or incongruent to the assigned condition. Interestingly, a significant survival processing advantage was obtained in all the experiments. However, the survival advantage for the congruent words did not reach significance. Their results clearly contradict the null effects of survival processing obtained by Butler et al. (2009). Therefore, Butler's results may not generalize beyond their particular

experimental design. They might have obtained their results since they used lists of words that were more incongruent than congruent to the assigned scenario. Nonetheless, both studies showed the powerful effect of congruity since processing words that are congruent with the encoding condition significantly improved later recall.

Since 2007, researchers have been able to rule out many different possible proximate mechanisms to explain the survival processing advantage like arousal, novelty, effortful processing, and schematic processing. However, no one has suggested viable mechanisms yet. Burns, Hwang, and Burns (2011) were able to determine at least one proximate mechanism responsible for this memorial advantage. They argued that the mnemonic advantage from survival processing is due to the combination of item-specific and relational processing, and that the effect occurs when survival processing is compared to another condition that uses only one type of processing (item-specific or relational), but eliminated when the control encoding condition encourages both types of processing at the same time. *Item-specific* processing is defined by the encoding of individual characteristics in each item. For example, the word “car” could be processed as me having a corvette and the word “yellow” as the color of my shirt. Each item has its own unique retrieval “cue” which improves discrimination between each item. On the other hand, *relational processing* refers to encoding items into groups sharing similar characteristics. Using the same example, the words “car” and “yellow” could be processed together as a yellow corvette and both items would likely be recalled at the same time if the participant thought about the vehicle. Relational processing improves retention by providing a structure between the words and creates an “organized retrieval” plan. As seen so far, many experiments used pleasantness rating as a control condition, which is known to create only item-specific processing (Burns, 1993; Burns & Schoff, 1998). In addition, Nairne and Pandeirada (2009) used a categorized list of words, which automatically promotes relational processing. Therefore, using pleasantness ratings on a categorized list of words should promote

both types of processing and recall performance should be superior to any conditions involving only item-specific or only relational processing (Burns et al., 2010). In a similar experiment, the data of Nairne and Pandeirada (2008) showed only a small survival processing advantage over pleasantness when using a related list of words. However, Burns and colleagues argued that this small recall advantage might be due to the congruity effect since the list of words from survival-related categories favored the survival condition. Consequently, a replication of this earlier study was needed.

Burns et al. (2011) contrasted the survival processing condition to pleasantness rating (item-specific processing) and category sorting (relational processing). They also used a list of words with obvious categorical relationships promoting relational processing (Experiments 1 and 2) and a list with ambiguous relationships that should have encouraged only item-specific processing (Experiments 3 and 4). Therefore, in each experiment, the survival encoding condition was compared to one condition involving only relational processing or only item-specific processing and the second expected to encourage both types of processing. The results showed that when survival processing was compared to a condition that promoted only one type of processing, the survival mnemonic advantage was present. However, when it was compared with a control condition promoting both types of processing, the retention advantage disappeared. Therefore, the data suggest that the survival processing effect is the result of survival processing inducing both types of processing (item-specific and relational) at the same time. Hence, they were able to suggest a proximate mechanism responsible for the survival processing effect.

Hart and Burns (2011) analyzed a potentially new dimension of survival that might also enhance memory performance: mortality salience. It seems logical that our own awareness of death is an evolutionary adaptation that promotes survival since no natural selection is possible after dying. By staying alive, an organism increases its chances of reproducing and passing its

genes to the next generation. Also, survival and death and closely related concepts and might even be inseparable since they both focus on life and death. Consequently, it is possible that mortality salience would enhance memory performance, in the same manner as survival processing. Burns and Hart investigated the effect of mortality (death) priming which consisted of completing a two item-questionnaire about dying before rating a list of words for their pleasantness. Mortality salience was compared to other primes like participant's thoughts about watching TV, or thinking about being paralyzed or experiencing dental pain. Their results showed that the mortality salience condition outperformed all the control conditions on a recall task and that neither positive nor negative affect differences are responsible for this effect. Therefore, it is clear that mortality salience enhances retention. However, the authors did not offer any proximate mechanisms responsible for this effect and they did not compare it to the survival processing effect to determine if the two effects are related.

Unpublished data conducted by Burns and colleagues compared the mortality salience effect to survival processing. They used two primes (death or dental pain) and two encoding conditions (pleasantness or survival processing) and asked participants to rate words from an unrelated list for their pleasantness or their survival relevance. The prime was given prior the encoding task and a recall test was administered after a short distraction period. The data showed that death priming outperformed the control prime (dental pain) only in the pleasantness condition. The combination of mortality salience and survival processing did not produce superior performance relative to survival processing alone. Therefore, it might be argued that mortality salience enhances memory but is redundant with survival processing, so it does not improve retention beyond that resulting from survival processing. A possible explanation could be that the mortality salience effect is only a component of the survival processing effect. However, no clear proximate mechanisms could explicate this redundancy and more research is needed in order to contrast the mortality salience and survival processing

effects.

The present experiment is designed to test again the relationship between the survival processing and the mortality salience effects, but with a related list of words. Previous research has shown that, when combined, the two effects do not produce any additional mnemonic advantage over using survival processing alone (Burns et al., 2011). The next step would be to test if we can reproduce the same results using a categorized list. The main reason for using words that are obviously categorized is to promote automatic relational processing, independently of the encoding condition. Therefore, both encoding conditions (survival processing and pleasantness rating) should produce item-specific and relational processing. My hypothesis is that mortality salience is a component of the survival processing effect and it will not produce additional retention when both effects are combined together. I also predict that both effects will be present when looking at them alone. Therefore, I should be able to reproduce the survival processing effect whereby participants in the survival scenario recall more words that those in the pleasantness rating condition. Also, the mortality salience group (death prime) should outperform the control condition (dental pain prime).

This experiment was also designed to find a plausible proximate mechanism responsible for the mortality salience effect. Multiples methods can be used to detect differences in the types of processing performed by different conditions. Recognition tests, item gains, and an analysis of cumulative recall curves are known to measure the amount of item-specific processing performed, whereas adjusted ratio of clustering (ARC) scores, item losses, and cumulative recall curves are good indicators of relational processing (Burns, 2006). The cumulative recall analysis will be one of the main techniques used to differentiate the amount of each type of processing between mortality salience and its control condition (dental pain) in the present experiment. Burns and Hebert (2005) introduced the cumulative recall analysis as an index of type of processing. As shown on the bottom panel of Figure 1, relational processing

produces curves that have a steep slope at the beginning and hit a plateau in the latter part of the recall period. On the other hand, a curve resulting from item-specific processing only is less steep at the beginning but increases more gradually in the latter part of the recall duration (Burns & Schoff, 1998). Also, conditions promoting both types of processing, like survival processing, always produce better recall performance than conditions performing only item-specific processing (see the top panel of Figure 1) or only relational processing (see the middle panel of Figure 1) Therefore, by looking at the cumulative recall curves of two different encoding conditions, it is possible to detect differences in the amount of each type of processing, item-specific and relational, across each condition. Using these curves, I hope to be able to propose a plausible proximate mechanism responsible for the mortality salience effect.

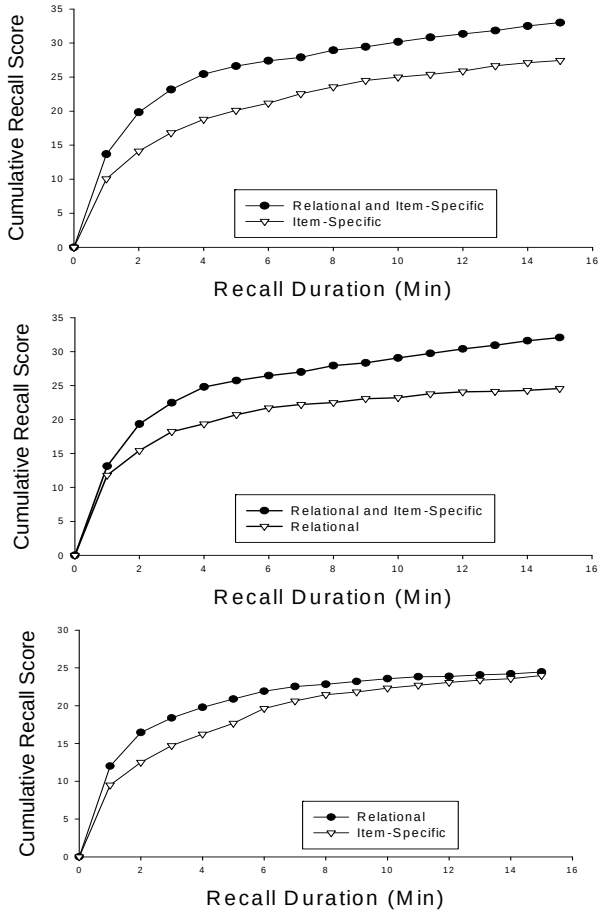

Figure 1. Mean cumulative-recall scores for various conditions tested in Burns and Schoff's experiment (1998)

Method

Participants. A hundred and twenty undergraduate students from Union College were either paid $6 or received credit toward an out-of-class activities requirement in their introductory psychology course in return for their participation. Everyone was tested in sessions lasting approximately 45 minutes. Thirty participants were randomly assigned to each of the four encoding groups (Death/Survival, Death/Pleasantness, Dental Pain/Survival, and Dental Pain/Pleasantness). Up to seven participants were tested in the same session but each participant was tested individually in cubicles. Stimuli were presented and controlled by computers.

Material and design. The list words were taken from the updated Battig and Montague norms (Van Overschelde, Rawson, & Dunlosky, 2004) and consisted of four words from each of 12 different categories (countries, sports, animals, colors, parts of the body, tools, weapons, professions, furniture, fruits, materials, and kitchen utensils). The order of presentation of the 48 items was random, but two words from the same category were never presented in adjacent positions. The set of words was presented in the same order for all participants.

A two-item questionnaire was used at the beginning of the experiment where participants needed to write about their emotions on two questions related to their specific prime group. Previous research has shown that this mortality salience manipulation is reliable in promoting death-related thoughts (Hayes, Schimel, Arndt, and Faucher, 2010). The wordings of each priming group were closely similar:

1) Please briefly describe the emotions that the thought of your own death (dental pain) arouses in you.
2) Jot down, as specifically as you can, what you think will happen to you as you physically experience death (dental pain) and once you are physically dead (once you have experienced it).

I also used the Positive and Negative Affect Schedule (PANAS) which measures positive and negative affect as states in order to measure each participant's feelings at the moment. It

should help in determining if the mortality salience effects can be explained by the negative or positive affect it creates in the participants. Previous research suggested that affect would not play a role in the difference in recall performance between the groups being primed (Pysczynski, Greenberg, & Solomon, 1999).

Procedure. Participants were randomly assigned to both a prime (death or dental) and an orienting task (survival or pleasantness) condition. They were first asked to complete a two-item questionnaire on either death or dental pain followed by completing the PANAS by rating 20 different emotions on a 1-5 scale, where 1 = *very slightly or not at all*, 2 = *a little*, 3 = *moderately*, 4 = *quite a bit*, and 5 = *extremely*. Afterward, each participant was orally given the instructions for their encoding condition. The directions were also shown on the computer before the beginning of the rating task in order to make sure that all participants fully understood them. The wording of the survival processing scenario and pleasantness-rating task were nearly identical to those given by Nairne and Pandeirada (2007) and were as follows:

Survival: "You will be shown a series of words on the computer screen one at a time. Your task is to imagine that you are stranded in the grasslands of a foreign land. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. For each word shown, we would like you to rate how relevant it would be for you in this survival situation. Some of the words may be relevant and others may not. It is up to you to decide. We would like you to rate each word on a 1-4 scale, where 1 = totally irrelevant, 2 = somewhat irrelevant, 3 = somewhat relevant, & 4 = totally relevant. You will rate the words by pressing the 1, 2, 3, or 4 key. You have six seconds to respond. Please try your best to respond before the six seconds are up."

Pleasantness: "The experiment in which you are about to participate is called a word characteristic study. The purpose of this study is to collect more information about the characteristics of individual words that we think might be important in reading. You will be shown a series of words on the computer screen one at a time. Your task is to rate how pleasant or unpleasant each word seems to you. Some of the words may be pleasant to you and others may not be pleasant. It is up to you to decide. We would like you to rate each word on a 1-4 scale, where 1 = totally unpleasant, 2 = somewhat unpleasant, 3 = somewhat pleasant, & 4 = totally pleasant. You will rate the words by pressing the 1, 2, 3, or 4 key. You have six seconds to respond. Please try your best to respond before the six seconds are up."

Words were presented individually, centered on the screen for 6 seconds each. The 1 to 4 scale was also shown on the screen under each word where 1 = extremely *irrelevant/unpleasant*, 2 = *somewhat irrelevant/unpleasant*, 3 = *somewhat relevant/pleasant*, 4 = *extremely relevant/pleasant*. These rating scales also remained on the computer screen during the entire rating task. Afterward, participants were read instructions describing a digit recall task, which was used as distractor task and lasted approximately 2 minutes. Seven digits (ranging from 0 to 9) appeared on the computer screen one at a time for 1 second; followed by a 15-s period in which participants could recall the digits by typing them in the order they were shown. After four trials of the digit recall task, participants were given 5 minutes to write the previously presented words on a recall sheet in any order they liked. To allow for the analysis of cumulative-recall scores, participants were instructed to draw a line under the last word recalled after each minute of the recall period. Finally, instructions for the recognition test followed the recall period. Participants had to circle the one unique word in each row of five that they believed they saw earlier on the computer screen. The four distractor items came from the same relational category as the list item. No time restriction was used for the recognition task. A debriefing period given at the end of the experiment explained the goals of the experiment.

Results

The significance level for all the statistics in this experiment was set at $p < 0.05$. Almost all participants were able to rate each of the 48 words within the 6 seconds allowed. However, if a participant did not rate a word before the allowed time, the data for that specific word (rating score and reaction time) were not calculated in the analysis.

Overall recall scores on test 1 and 2. The mean recall scores for both tests are shown in Figure 2. A 2 (type of task: survival or pleasantness) x 2 (type of prime: death or dental) between subjects analysis of variance (ANOVA) was performed on the recall scores for each

test. For the first test, survival processing did significantly better than the pleasantness rating condition, $F(1,116) = 5.53$, $p < .05$, replicating the typical survival effect found by Nairne, Thompson, and Pandeirada (2007). Neither the main effect of type of prime nor the interaction approached significance, $F(1,116) = .54$, $p = .465$ and $F(1,116) = .736$, $p = .736$ respectively. For the second test, recall for the survival processing group was again significantly higher than for the pleasantness group, $F(1,116) = 4.59$, $p < .05$. Although it did not quite reach the significance level, a mortality salience effect was evident in the second test, $F(1,116) = 3.63$, $p = 0.059$, suggesting that death priming can enhance memory. The interaction between the type of prime and the type of task was not significant, $F(1,116) = 1.42$, $p = .236$. In other words, as can be seen in Figure 2, a combination of mortality salience and survival processing did not produce better performance than survival processing alone. This may suggest that mortality salience is a component of the overall survival processing effect.

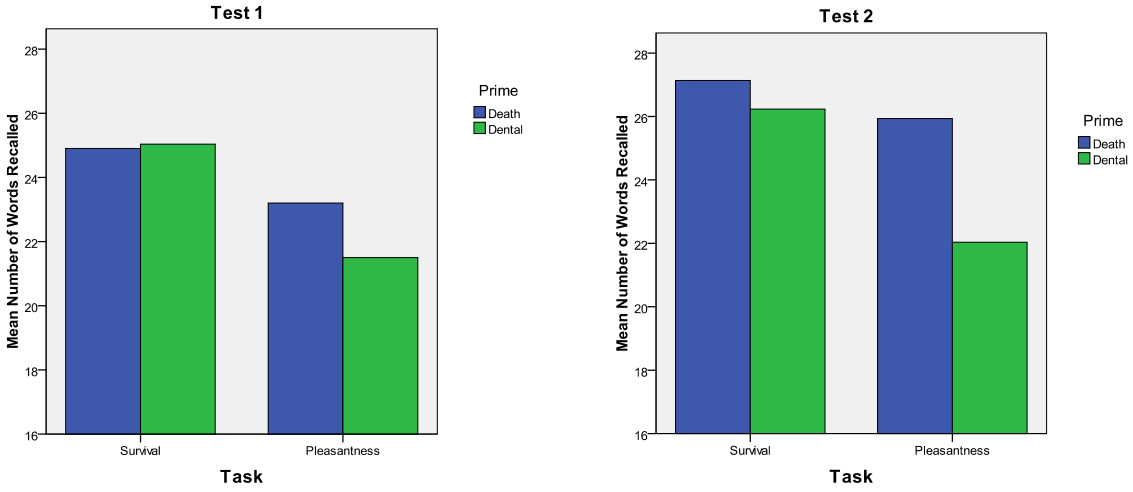

Figure 2. Mean cumulative number of words recalled of each test.

Recognition scores. The percentage of list words recognized correctly was above 95% in each condition and did not differ significantly. The results were omitted in the analysis since no conclusion could be made from the data due to the ceiling effect.

Ratings and reaction times. The mean ratings and reaction times of the participants in each condition are shown in Table 1. A 2 (type of task) x 2 (type of prime) ANOVA performed on the reaction times revealed no significant differences between the two tasks or the two primes, $p = .425$ and $p = .684$ respectively. For the ratings, the participants in the pleasantness condition rated words significantly higher than the ones in the survival condition, $F(1,116) = 48,39$, $p < .05$. Neither the main effect of type of prime nor the interaction was significant. However, previous research has shown that neither the ratings nor the reaction times can be responsible for the survival processing effect (e.g., Nairne et al., 2007).

PANAS scores. After completing the two-item questionnaire (death or dental pain), participants were asked to complete the PANAS by rating different emotions and feelings. The results, shown in Table 1, should evaluate if any mortality salience effects on recall could be due to elicitation of negative or positive affect. A 2 (type of task) x 2 (type of prime) ANOVA was performed on each of the affect (positive and negative) scores. For negative affect, there were no significant effects. For the positive affect scores, death priming was significantly higher than the dental pain condition, $F(1,116) = 8.90$, $p < .05$. This might suggest a possible increase in memory due to a significant increase in the positive emotions of the participants in mortality salience (death) condition. However, previous research has suggested that affect does not play a significant role in other mortality salience effects (Pyszczynsky, Greenberg, & Solomon, 1999).

	Task				Prime			
	Survival		Pleasantness		Death		Dental	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Ratings	2.32	0.29	2.69	0.29	2.47	0.35	2.55	0.34
Reaction Time (ms)	2,390	420	2,330	411	2,344	377	2,375	452
Positive Affect	27.70	7.27	26.60	6.78	28.98	6.68	25.32	6.93
Negative Affect	16.53	5.70	16.50	5.00	16.87	5.74	16.17	4.92

Table 1. Mean ratings, reaction time, and PANAS scores as a function of the prime and the task.

Cumulative-recall curves. The cumulative number of words recalled across the two 5-min periods was plotted into a curve in order to evaluate the types of processing produced by the encoding conditions. Differences emerging in the first few minutes of the recall period suggest a difference in the amount of relational processing. On the other hand, differences emerging in the last few minutes suggest a difference in the amount of item-specific processing (Burns, 2006). A close inspection of the results, shown in Figure 3, shows that death and dental primes in the survival encoding condition produced nearly identical recall curves, suggesting that both conditions processed equivalent amounts of item-specific and relational information. However, when the encoding condition was pleasantness rating, the curves differ significantly in the later part of the graph (see the right panel). This suggests that mortality salience produced a memorial benefit due to an increase in item-specific processing, which is characterized by a constant increase in words remembered in the later part of the recall test.

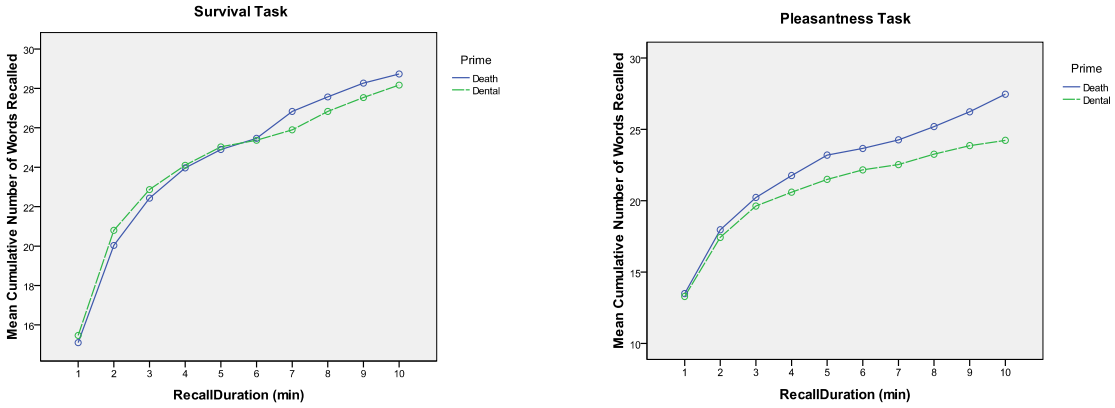

Figure 3. Mean cumulative number of words recalled for the primes in each encoding task,

Items gains and losses. Another method of evaluating the amount of item-specific processing performed is measuring the number of new words recalled on the second test that were not recalled on the first test (item gains) (see Burns, 2006). The item gain results are shown in the left panel of Figure 4. An increase in gains should show up for conditions

performing more item-specific processing. A 2 (type of task) x 2 (type of prime) ANOVA reveals that the death priming condition produced a significant increase in item gains compared to the dental pain condition, $F(1,116) = 7.43$ $p < .05$. No other significant differences were observed. In accordance with the cumulative-recall curves, this suggests that mortality salience creates a mnemonic advantage due to an increase in item-specific processing only.

The number of items forgotten from test 1 to test 2 (item losses) were also calculated (see right panel of Figure 4) and the ANOVA showed that neither the type of prime nor the type of task had an effect on item losses. Previous research has shown that item losses are a good measure of relational processing. Therefore, these results imply that differences in relational processing are not responsible for either the survival processing effect or the mortality salience effect.

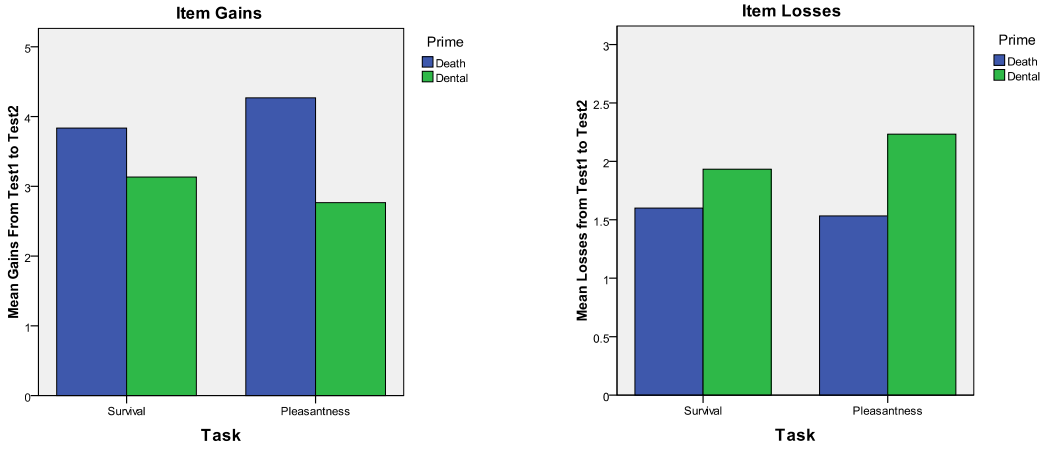

Figure 4. Mean words gained (left panel) and lost (right panel) from test1 to test2.

Clustering scores. The ARC score is another method used to investigate the amount of relational processing performed by each subject. The ARC score assesses the extent to which words from the same category are recalled next to each other. If participants cluster categorically related words together more often than would be expected by chance, it can be assumed that they encoded the categorical relationship between the words. An ARC score of

+1.00 indicates perfect clustering, thus a high level of relational processing. On the other hand, a score of 0.00 indicates chance-level clustering. The mean ARC scores are presented in Figure 5 and show that all four conditions produced a high level of clustering; suggesting that all groups achieved a high level of relational processing, which was expected. No significant differences were observed between conditions, which suggests that all performed an equivalently large amount of relational processing.

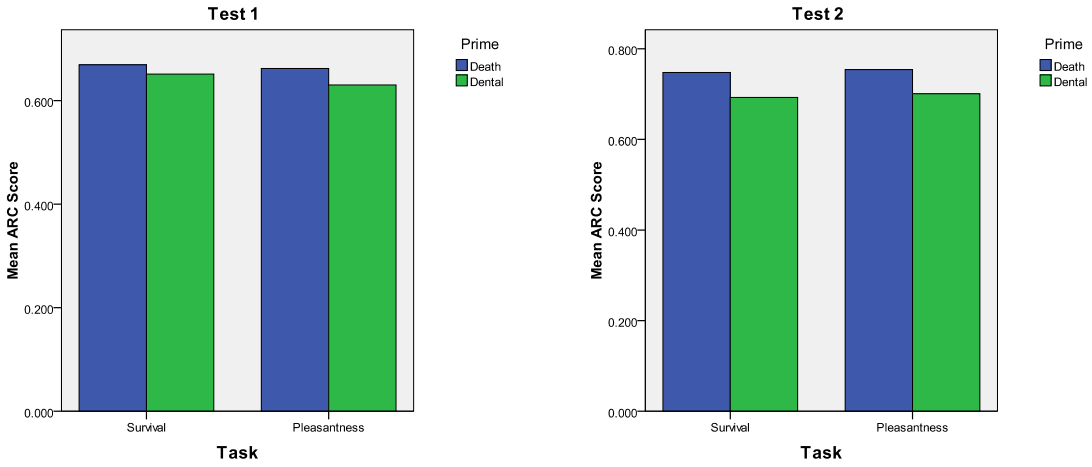

Figure 5. Mean ARC score from all four conditions on each test

Discussion

The results of this experiment offer compelling evidence that mortality salience is a component of the survival processing effect. Both effects, survival and mortality salience, were replicated separately, but no additional mnemonic advantage was obtained when survival processing and death priming were combined together, suggesting that mortality salience is redundant with the survival processing effect.

The first important step in this experiment was to reproduce the typical survival processing effect found by Nairne et al. (2007), which was replicated on both recall tests, even when a related list of words was used instead of an unrelated list. Previous research has shown that survival processing outperforms pleasantness encoding in an unrelated list of words,

presumably because pleasantness rating encourages only item-specific processing while survival processing encourages both item-specific and relational processing (Burns et al., 2011). On the other hand, a categorized list automatically promotes relational processing, regardless of the encoding task used (Hunt & Einstein, 1981). Therefore, with a related list of words, both encoding conditions were using item-specific and relational processing. Obtaining the survival processing effect was surprising under these conditions. This suggests that the survival processing effect obtained in this experiment might be due to an additional use of relational processing compared to the pleasantness condition. Normally, pleasantness rating does not induce relational processing, but it did in this experiment only because of the categorized list. On the other hand, survival processing already uses a significant amount of relational processing. The related list produced even more relational processing, which may explain why the typical mnemonic advantage was still found in the survival scenario. Of course, this does not explain why I found an effect using a related list whereas Burns et al. (2011) did not find any survival processing effect. One small difference between the experiments that may explain the discrepancy concerns the order of words in the list. Burns et al. presented the list of 48 words in three sets, with each set containing four words from each of four categories, whereas I presented the words in random order. It seems likely that the presentation procedure used by Burns et al. would encourage all participants to perform more relational processing, perhaps boosting the pleasantness rating group up to the same level as the survival processing group.

The difference in reaction times for both conditions cannot explain the survival processing effect since the difference between groups did not reach significance. On the other hand, a significant difference in ratings was obtained, where participants in the pleasantness condition rated the words higher than those in the survival condition. In general, words rated higher are remembered better, a finding referred to as congruence (Craik & Tulving, 1975). Therefore, pleasantness should have theoretically done better than survival in the recall tests,

which did not happen. This shows how strong and consistent the survival processing effect is in the human mind.

The second step in this experiment was to duplicate the mortality salience effect found by Hart and Burns (2011). Although it did not quite reach the standard significance levels, a mortality salience effect was obtained in the second 5-minute recall period. This replicates the results obtained by Hart and Burns (2011) when they first tested the mortality salience effect. The significant difference, compared to dental pain, in positive affect from the PANAS might account for the mortality salience effect. However, previous research suggested that affect, positive and negative, does not play a significant role in other mortality salience effects tested previously (Pyszczynski et al., 1999). A difference in the arousal level should also be ruled out since both primes, death and dental pain, should produce roughly the same aversive levels of arousal. The increase in recall from the death prime suggests that there must be a non-emotional component responsible for the mortality salience effect and it is reasonable to believe that the mortality salience effect on retention is real and significant.

For the first time, a plausible explanation of the proximate mechanism for mortality salience was developed. Both the cumulative recall scores and the item gains are consistent with this explanation and suggest that the mortality salience effect is due to an increase in item-specific processing. First, the cumulative recall curves for the pleasantness task shows a significant difference in the later part of the curve between the subjects in the death and dental pain conditions. This result is normally explained by a difference in the amount of item-specific processing (Burns, 2006). Another way to measure the amount of item-specific processing is by using the number of items gained from one test to another. Again, there was a significant increase in item gains for the death prime condition compared to the control condition. Previous research has shown that item gains tended to increase as the amount of item-specific processing also increased (Burns, 1993). Having two different sources suggesting more item-specific

processing when mortality salience is compared to a control condition provides strong evidence that the effect is real and consistent. In addition, the number of item losses is a good measure of the amount of relational processing (Burns, 1993). In this experiment, all four groups had about the same amount of item losses and no significant differences were found. The same null results were found for the ARC scores, which also measure relational processing. This suggests that the mortality salience effect cannot be explained by a difference in relational processing, confirming again the effect is due only to an increase in item-specific processing. Therefore, a plausible mechanism for the mortality salience effect has been found for the first time.

It would be interesting to see if the mortality salience effect also occurs when mortality salience is applied as a processing task instead of as a prime. So far, no one has tried to compare the mortality salience and the survival processing effects when both are used as a task. It is possible that, when used as a task, the effect of mortality salience will get larger since the subjects will have death thoughts during the entire experiment and not only during the first minutes when they answer the two-item questionnaire (prime).

Being able to recreate the survival processing and the mortality salience effects was critical in order to verify that the effects occur with the present procedures. Therefore, the lack of retention improvement when the mortality prime and the survival task are combined together, can not simply be due to a failure to replicate either effect.. Having no additional retention when the death prime and the survival task were combined suggests that the two effects might be the same. However, the present results show that both effects are different since they are not using the same amount of item-specific and relational processing. When compared to a control condition like pleasantness, previous research has shown that the survival processing effect is explained by an increase in relational, but not item-specific processing (Burns et al., 2011). On the other hand, the present experiment shows that the mortality salience effect is due to an increase in item-specific processing, but not relational. Therefore, it is clear

that the mortality salience effect is not entirely the same as the survival one since both are using different amount of each type of processing.

Another plausible interpretation of the null result obtained when the two effects were combined might be that one effect is embedded in the other, and many arguments suggest this explanation. First, the results show that both effects promote different types of processing when they are handled independently, but the cumulative recall curves produced by the two primes on the survival task show that the mortality salience effect has disappeared since both curves are almost identical. A functional perspective might explain this result since the survival processing effect is more complex than the mortality salience effect. By definition, there is a mortality component already included within the survival processing effect since the main goal of surviving is to stay alive (i.e. not die). Therefore, death thoughts are associated with the survival scenario. However, in order to survive, someone needs to do more than just simply thinking about staying alive. He or she also needs to do some specific actions like finding food and water, finding or building a shelter, being able to protect himself/herself, and so on. The idea of survival is much more complex than the idea of mortality, and this complexity may enlist more memory systems and promote both types of processing. Therefore, it is logical to argue that the mortality salience is a component of the survival processing effect and the results of the present experiment are consistent with this perspective.

The objective of this experiment was to test the relationship between the survival processing effect and the mortality salience effect. I was not only able to provide indisputable evidence that mortality salience is a component of the survival effect, but I was also able to explain the proximate mechanism responsible for the mortality salience effect alone (i.e., an increase in item-specific processing). These results provided a novel explanation for a new and interesting effect.. It would be interesting to compare both effects as primes or as tasks. By using a death prime and a survival task, it is possible that the processing task demanded more

attention from the subjects than the death prime. On the other hand, if both conditions were designed as tasks, a survival task and a death task, participants from both tasks would have spent the same amount of time focusing on death/survival. In gathering this information, we would be able to further explain the results obtained in this experiment and obtain more details about the two effects and their relationship together. Even if this experiment gives a good overview of the relationship between the mortality salience effect and the survival processing effect, there are still a lot that needs to be discovered about both effects and their possible connections.

References

Anderson, J. R., & Schooler, L. J. (1991). Reflection of the environment in memory. *Psychological Science*, 2, 396- 408.

Bousfield, W. A., & Sedgewick, C. H. (1944). An analysis of restricted associative responses. *Journal of General Psychology*, 30, 149-165.

Burns, D. J. (1993). Item gains and losses during hypermnesic recall: Implications for the item-specific-relational information distinction. *Journal of Experimental Psychology: Learning, Memory, and Congnition*, 19, 163-173.

Burns, D. J. (2006). Assessing Distinctiveness: Measures of Item-Specific and Relational Processing. In R. R. Hunt & J. B. Worthen (Eds.), *Distinctiveness and memory* (pp. 109-130). New York, NY: Oxford University Press.

Burns, D. J., Burns S. A., & Hwang A. J. (2011). Adaptive Memory: Determine the Proximate Mechanisms Responsible for the Memorial Advantages of Survival Processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 37, 206-218.

Burns, D. J., Griffith, S. E., Burns, A. D., & Hart, J. J. (2011). Adaptive Memory: The Survival Scenario Promotes More Relational Processing, but not More Item-Specific Processing than Other Scenarios. Unpublished manuscript.

Burns, D. J., & Hebert, T. (2005). Using Cumulative-recall curves to assess the extent of relational and item-specific processing. *Memory, 13*, 189-199.

Burns, D. J., & Schoff, K. M. (1998). Slow and steady often ties the race: The effects of item-specific and relational processing of cumulative recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 1041-1051.

Butler, A. C., Kang, S. H. K., & Roediger, H. L. (2009). Congruity Effects Between Materials and Processing Tasks in the Survival Processing Paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 35, 1477-1486.

Craik, F.I.M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, 104, 268-294

Hart J., & Burns, D. J. (2011). Nothing Concentrates the Mind : Thoughts of Death Improve Recall. Unpublished manuscript.

Hayes, J., Schimel, J., Arndt, J., & Faucher, E. H. (2010). A Theoretical and Empirical Review of the Death-Thought Accessibility Concept in Terror Management Research. *Psychological Bulletin*, 136, 699-739.

Hunt, R. R., & Einstein, G. O. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning and Verbal Behavior, 20*, 497-514.

Indow, T., & Togano, K. (1970). On retrieving sequence from long-term memory. *Psychological Review*, 77, 317-331.

Kang, S. H. K., McDermott, K. B., & Cohen, S. M. (2008). The mnemonic advantage of processing fitness-relevant information. *Memory & Cognition*, 36, 1151-1156.

Klein, S. B., Robertson, T. E., & Delton, A. W. (2010). Facing the future: Memory as an evolved system for planning future acts. *Memory & Cognition*, 3, 13-22.

Latta, R. G. (2010) Natural selection, variation, adaptation, and evolution: a primer of interrelated concepts. *International Journal of Plant Sciences*, 171, 930-44.

Nairne, J. S. & Pandeirada, J. N. S. (2008). Adaptive memory: Is survival processing special? *Journal of Memory and Language*, 59, 377-385.

Nairne, J. S. & Pandeirada, J. N. S. (2008). Adaptive memory: Remembering With a Stone-Age Brain. *Current Directions in Psychological Science*, 17, 239-243.

Nairne, J. S. & Pandeirada, J. N. S. (2010). Adaptive memory: Ancestral priorities and the mnemonic value of survival processing. *Cognitive Psychology*, 61, 1-22.

Nairne, J. S., & Pandeirada, J. N. S. (2011). Congruity Effects in the Survival Processing Paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 37, 539-549.

Nairne, J. S., Thompson, S. R., & Pandeirada, J. N. S. (2007). Adaptive memory: Survival processing enhances retention. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 33, 263-273.

Nairne, J. S., Thompson, S. R., & Pandeirada, J. N. S. (2008). Adaptive Memory: The comparative value of survival processing. *Psychological Science*, 19, 176-180.

Otgaar, H., Smeets, T., & Van Bergen, S. (2010). Picturing survival memories: Enhanced memory after fitness-relevant processing occurs for verbal and visual stimuli. *Memory & Cognition*, 38, 23-28.

Paivio, A. (2007). *Mind and its evolution: A dual coding theoretical approach*. Mahwah, NJ: Erlbaum.

Pyszczynski, T., Greenberg, J., & Solomon, S. (1999). A dual-process model of defense against conscious and unconscious death-related thoughts: an extension of terror management theory. *Psychological Review, 106,* 835-845.

Roediger, H. L., Stellon, C. C., & Tulving, E. (1977). Inhibition from part-list cues and rate of recall. *Journal of Experimental Psychology: Human Learning and Memory*, 3, 174-188.

Todar, Kenneth. (2011). Bacterial Resistance to Antibiotics. Online Textbook of Bacteriology. (http://www.textbookofbacteriology.net/resantimicrobial.html)

Weinstein, Y., Bugg, J. M., & Roediger, H. L., III. (2008). Can the survival recall advantage be explained by basic memory processes? *Memory & Cognition*, 36, 913-919.