Survival Processing and False Memories

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ABSTRACT

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Some researchers speculate memory systems are adaptations that arose to enable the storage of survival related information. Supporting this view, information processed for survival relevance and death relevance has been shown to produce a memory advantage that is superior to deep processing control conditions. While these procedures increase recall, the information retrieved is not necessarily accurate. The purpose of the present study was to investigate the effects of survival processing and death processing on the formation of false memories. In addition, through analyses of cumulative recall curves the extent of relational and item-specific processing was examined to explore the proximate mechanisms underlying the effects.

Participants were placed into a survival, death, moving, or pleasantness condition. They were instructed to rate lists of words, which have been shown to produce false memories, for their relevance to the given scenarios. It was predicted that if death processing and survival processing are related, then participants would recall a similar number of list items and false memories. Although not significant, analyses of the surprise memory task revealed the survival condition had the highest numerical recall of list items, while the death condition had the lowest. The death condition significantly differed from the other conditions by producing the highest recall of false memories. The survival condition did not lead to an increase in false memories. Overall, the results suggest survival and dying scenarios do not share similar underlying mechanisms.

SURVIVAL PROCESSING: AN OVERVIEW

Typically, evolutionary theories are used to explain modern day occurrences (Nairne, Pandeirada, & Thompson, 2007). These inferences can be problematic because evolutionary explanations often rely solely on logic; researchers cannot delve into the minds of human ancestors, or know with certainty the conditions prevalent in ancestral environments, thus they are unable to produce empirical evidence for their hypotheses.

Instead of observing a modern day phenomenon and trying to explain the occurrence through evolutionary theory, however, researchers occasionally use evolutionary reasoning to make predictions about human behavior. Researchers are currently using this approach to speculate on the development of human memory (Nairne et al., 2007). Why do we have memories? From an evolutionary perspective, episodic memories are adaptations that allow humans to reflect on episodes from the past not simply to reminisce, but to plan for the future (e.g., Kahneman, 2010). According to researchers, memory systems formed as a result of evolutionary pressures (Nairne et al., 2007). By storing survival-relevant information, such as the location of food resources or dangerous predators, memories increase the genetic fitness of individuals by enhancing their likelihood of surviving and reproducing (Nairne et al.).

If memory systems are adaptations, then memory systems should be the most efficient in situations reminiscent of the ancestral contexts they arose from (Nairne et al., 2007). Furthermore, if memory systems evolved because they enabled individuals to store information related to survival, then our modern memory systems should also be sensitive to processing and encoding survival related information. Additionally, if memory systems are attuned for encoding this particular type of information, then instilling thoughts of survival should enhance memory recollection (Nairne et al., 2007).

In order to explore one possible reason underlying the evolution of human memory: that memory systems evolved to store survival-relevant information, Nairne et al. (2007) examined how well stimuli were remembered when they were processed for their survival relevance. Individuals in the experimental condition were instructed to imagine themselves deserted in the grasslands of a foreign land, lacking basic materials necessary for survival. They were informed over the next few months they would need to find food, water, and a means of protecting themselves from predators. Next, they were instructed to rate common nouns for their survival significance, while those in the control condition rated the same nouns for their personal significance, pleasantness, or relevance to moving to a foreign land (Nairne al., 2007). Next, participants were given a distractor task before the administration of a surprise memory test. Across four experiments, the researchers found participants' memory systems were more responsive to the encoding of nouns processed for their survival relevance than for all other conditions. In other words, both recall and recognition was higher for the survival group than for any of the control groups.

Nairne al. (2007) wanted to extend their findings and rule out alternative possibilities that could explain the survival processing advantage. They found the survival processing effect for both within-, as well as between-subject designs. They questioned whether the level of processing might be deeper for survival than the other conditions. As a result, they used a self-referencing task as a comparison group in their fourth experiment. This task instills a deep, semantic level of processing that presumably is not related to survival. They obtained the same recall advantage for the survival condition, suggesting that survival processing significantly enhances retention above that produced by self-referential processing. In addition, they also measured reaction times, or the amount of time individuals spent making decisions regarding the relevance of the nouns to the scenarios or their pleasantness value. They speculated if individuals spent longer amounts of time making decisions in the survival condition than in the other conditions, then reaction time might be the reason for the survival enhancement effect. They found no difference, however, in participants' reaction times across conditions. Finally, they wanted to examine whether the enhancement was due to the beneficial effects of congruous target encodings: individuals who rate the words highly are more likely to remember the words than if they rate them lower (see Nairne et al., 2007). Consequently, if participants rated the nouns on average more highly in the survival condition compared with the other conditions then the results could be attributed to this congruity effect. The researchers found no significant difference in ratings between conditions and were thus able to rule out the influence of this effect. Overall, participants who rated common nouns for their survival relevance had the best recall and recognition in their studies. Therefore, their results support the notion our memory systems evolved to give humans a unique survival advantage by recording survival related information (Nairne al., 2007).

In accordance with Nairne et al.'s findings (2007), Weinstein, Bugg and Roediger (2008) first replicated their original experiment and also found a significant difference between individuals placed into the grassland survival scenario and those assigned to other deep processing conditions. They also claimed the elaborateness of the instructions might have caused participants to process the scenario more deeply, which in turn lead to the memory enhancements. Thus, in their second experiment, they tested whether the recall advantage continued when the control condition matched the survival processing condition in terms of schematic processing, or level of detail given to the scenario. For their new scenario, they used an urban, modern environment that only differed from the survival scenario in terms of the situations' evolutionary relevance. They found individuals who rated words for survival relevance and were placed into the grasslands scenario had superior recall to those placed into the city scenario. This finding suggests modern memory systems have ancestral priorities, which provides further support for an evolutionary account of human memory.

Exploring the survival processing enhancement effect further, a subsequent study conducted by Nairne and Padeirada (2010) replicated and extended Weintein et al.'s (2008) results. In the study, the researchers focused on the ultimate mechanism(s) underlying the processing advantage. They used two survival scenarios in their study: participants either read about an ancestral environment, the grasslands, or about a modern environment, a city, before they were given a word list that they would later be asked to recall. They found that participants who imagined being placed in the grasslands scenario had greater recall of list words than participants who imagined being placed in the city scenario. They concluded our memory systems are sensitive to ancestral priorities, and attuned to encoding survival related data. The responsiveness of memory systems to ancestral environments provides further support for the theory that memories are the result of evolutionary pressures (Nairne & Pandeirada, 2010).

On the other hand, when Soderstrom and McCabe (2011) tried to replicate these findings, they found no difference between participants' recall rates for the modern, or city, and the ancestral, or grasslands scenarios. Further, they found recall was actually greater for participants who were placed into the modern survival scenario where zombies were described as the threat compared with participants placed into the ancestral scenario where predators were the threat, thereby challenging the notion human memory adapted for survival processing and would therefore be most efficient in ancestral environments.

Further illuminating the strength of the survival processing effect, Nairne, Pandeirada, and Thompson (2008) found recall for survival processing of items was greater than recall for deep processing control conditions which included: imaginal processing, pleasantness rating, generation, and intentional memory. Bell, Roer, and Buchner (2013) also conducted a study testing the generalizability of the survival processing effect. They used a suicide scenario as a comparison group, and found participants given the survival scenario had superior recall when compared with those in the suicide scenario. Thus, the survival processing effect does not appear to be due to enhanced processing resulting from the negativity of the subject matter.

The findings across various experiments demonstrate the strength of the survival processing enhancement effect. Overall, the researchers' discoveries that memories are enhanced when participants are instructed to rate words for their survival relevance support the notion our memory systems resulted from evolutionary pressures. The survival processing enhancement effect appears to be a result of this adaptation that is visible today.

Survival Processing: Proximate Mechanisms

While researchers have speculated about the ultimate reasons for the survival processing enhancement effect, some have begun to study the proximate mechanisms. For example, Burns, Burns and Hwang (2011) questioned whether differences in item-specific and relational processing could explain the effect. They analyzed cumulative-recall curves, and measured item gains, and item losses over subsequent memory tests in order to assess differences in item-specific and relational processing. Because I plan to use several of these measures, they will be will described next.

Item-specific processing occurs when individuals encode distinctive characteristics of individual items, thereby providing unique retrieval cues for each item. Relational processing occurs when individuals encode how items relate to one another. Therefore, this type of processing creates an organized retrieval plan for the encoded information.

In order to differentiate between item-specific and relational processing, the analysis of cumulative-recall curves may be used. It has been shown that item-specific processing produces more gradual cumulative-recall curves that consistently approach asymptotic levels when compared with relational processing (e.g., Burns & Schoff, 1998). The assumption is that when an individual uses item-specific processing, the cues they encode aid in single-item retrieval only, which accounts for the slower, steadier recall. On the other hand, relational processing produces cumulative-recall curves with steeper initial slopes that taper off more quickly as they approach asymptotic levels because the relational cues provide a systematic method of recovery of the list items, which results in rapid initial recall of word items that have been grouped together (e.g., Burns & Schoff, 1998).

Burns (1993) also argued that item-specific and relational processing can be deduced by looking at the number of item gains and item losses in a repeated testing procedure, whereby participants are given multiple recall tests in a row without any additional studying between testing. The amount of relational processing an individual uses is inversely related to item losses, or the number of items forgotten across subsequent recall tests, because relational processing provides organized retrieval of the list items, where the same relational cues are used across different tests. Moreover, the amount of item-specific processing an individual uses is directly related to item gains, or the number of new items that are recalled across subsequent tests that are not recalled during the first test. An increase in item-gains is indicative of item specific processing because there are many potential retrieval cues for each item, and some cues that are not used on the first test may be used on later tests (Burns, 1993).

Through the examination of cumulative-recall curves, Burns, et al. (2011) have examined the proximate mechanisms likely underlying the survival processing enhancement effect. Across four experiments, they found survival processing produced superior recall to conditions that elicited only relational processing, or only item-specific processing. However, when control conditions had both relational and item-specific processing, the survival enhancement effect disappeared. The cumulative-recall curves illustrated the survival-rating task produced a significantly steeper curve than the one produced by the pleasantness group. However, survival processing tended to produce superior performance only in the later portions of the recall period compared to conditions performing only relational processing. Their results signify that survival processing most likely promotes both relational and item-specific processing, which makes it unique because most control conditions produce only one type of processing.

Burns, Hart, Griffith and Burns (2012) decided to test this two-process explanation using non-survival scenarios as control conditions, rather than pleasantness rating. In both a between-lists and within-list design, researchers found participants in the survival scenario had improved recall relative to those in the moving scenario. Based on their analysis of cumulative-recall curves, which showed that the recall difference only emerged late in the recall period, it was concluded that the difference in recall was caused by a difference in the level of item-specific processing, and not relational processing. Thus, while survival processing enhances both item specific and relational processing, the overall memory advantage relative to other *scenarios* may be due only to greater item-specific processing.

False Memories

Researchers have begun to assess the accuracy of the memories that are elicited by the survival processing effect. In particular, they have examined the effects of survival processing on participants' memories using the Deese, Roediger, and McDermott (DRM) procedure, which is a popular research method for creating and studying false memories, or recollections of information that is never directly presented (Deese, 1959; Roediger & McDermott, 1995).

How are false memories created?

Fuzzy trace theory asserts that during the formation of a new memory an individual creates two memory traces (Brainerd & Reyna, 1998; Reyna & Brainerd, 1995). The first trace is a detailed description, while the second trace has semantic value and is a more general overview of the information being stored. According to theorists, the second trace remains in memory much longer than the first trace. Thus, if a lot of time elapses between encoding and retrieval of a particular memory, then individuals will use the second "fuzzier" trace, which ultimately leads to a higher instance of false recollections.

Alternatively, some researchers argue source-monitoring theory adequately explains the formation of false memories (Johnson, Hashtroudi, & Lindsay, 1993). The theory proposes if individuals do not encode sufficient detail in memory, the lack of information does not allow accurate determination of the source of the information as either internal or external. Therefore, upon retrieval an individual must make a judgment call as to the source of the information. Occasionally, this decision making process results in misattributions. Typically, externally generated memories are more elaborate. If an imaginary event is given a lot of detail, however, an individual may incorrectly attribute the memory to an external source, thereby creating a false memory of the event.

Activation Monitoring theory is an extension of the source monitoring view, and is now more prominent than both the original source monitoring theory, and spreading activation theory (Gallo & Roediger, 2002; Roediger, Watson, McDermott, & Gallo, 2001). This theory, which lays the basis for the DRM procedure, contends semantically related words cause particular concepts to become activated, or more readily brought to consciousness, and once activated individuals misremember the related concept as being externally generated because of source identification failure.

All of these theories have been used to explain the formation of false memories in the DRM procedure. During this procedure, participants are presented a series of word lists comprised of list items that are all centered around one critical item, which is not presented on the list. For example, list items may include: bed, rest, tired, dream, and slumber, which all center around the critical lure, sleep. Typically, researchers find participants false recognize or recall the critical lure as frequently as they remember list items. Individuals are also confident in their assertions that the false memories are in fact, true (e.g., Payne, Blackwell, & Neuschatz, 1996).

Exploring the mechanisms underlying illusory memories, Burns, Martens, Bertoni, Sweeny, and Lividini (2006) analyzed cumulative-recall curves, item gains, and item losses of both list items and critical lures using the DRM paradigm, or false memory procedure, on multiple tests. The first experiment examined item gains and losses in order to compare the amount of relational and item-specific processing participants perform on critical lures and list items. Participants were informed they would hear a list of words presented that they would later be asked to recall. They were given several DRM lists in succession before they were asked to recall all of the words. An analysis of the cumulative recall curves revealed the critical lures had slower, steadier recall when compared with the list items. Further, critical lures produced more item gains, and list items produced fewer item losses across successive tests. These findings lead the researchers to infer the list items received more relational processing, while the critical lures received more item-specific processing.

The researchers proposed two possible hypotheses to explain the surprising finding that critical lures seemed to receive more item specific processing when compared with list items. First, critical lures may receive more conceptual detail as a result of being activated by the list items. Second, critical lures may receive relational processing, but the encoded relational information is not used as part of the individual's retrieval scheme.

According to the first hypothesis, if critical lures receive more detail, then they should continue to receive item-specific processing when physically presented in the list. They should also have more item gains than list items across successive tests. If the second explanation is correct, then physically presenting critical items in the list should cause relational information to be integrated into the retrieval plan.

To test between these two explanations, they conducted an experiment where they replaced one list item from each of the ten DRM word lists with the critical lure (Burns et al., 2006). By physically presenting the critical lure, the researchers allowed the critical lures to be used in the participant's retrieval plan. After examining cumulative-recall curves, researchers found the critical items continued to receive more item-specific processing, but also received relational processing, to the extent that they received as much relational processing as the other list items. In their final experiment, when they presented critical items to participants that were less related to the other list items they found the critical lures' item-gain advantage from the initial experiments was eliminated. Thus, they concluded critical items that are not physically presented receive more item-specific processing than list items because of their strong association to the other list items, which causes an increase in activation. Their findings also support the contention that critical lures are only incorporated into an organized retrieval plan if they are physically presented in the DRM list.

False Memories in Survival Processing

If survival processing is a result of natural selection, Otgar and Smeets argued that it should prioritize the encoding of true memories while minimizing false recollections (2010). They used net accuracy scores, or ratios of true recall to true recall plus false recall, to examine the accuracy of adults' adaptive memories. They found no recall advantage in terms of net accuracy for survival processing because survival processing increased both true and false memories. However, they noted that these false memories may not necessarily be maladaptive, but could be viewed as side effects of an adaptive memory strategy, namely the ability to attend to survival-related materials by scanning the environment quickly, and efficiently while gleaning survival-related information. Even if the information is not entirely accurate, if it is relevant to one's survival processing it still may enhance an individual's ability to survive. For instance, if an individual falsely recalls the location of a predator within the environment, the false information may cause them to be more cautious, and attune to other possible dangers within the environment, which ultimately increases his or her genetic fitness.

Howe and Derbish (2010) found that not only does survival processing produce high true and false recall, but survival-related words (battle, conflict, disease) were also better recalled and were more susceptible to the false memory illusion than negative or neutral words that were not survival relevant, regardless of whether an intentional memory paradigm or incidental memory task was used. Further, survival-related concepts, such as injury and death were more likely to promote false memories than control concepts, exemplifying the broadness of the effect. Based on these findings, humans appear to process survival information differently than other materials, which cause an increase in false recognition and recall.

Death and Survival Processing

Theorists have speculated that survival processing may activate numerous encoding mechanisms (Nairne et al., 2007). Recently, some researchers speculated the memorial benefits that occur from thoughts of survival might be the result of death related cognitions (e.g., Burns, Hart, & Kramer, 2013). This assumption is logical because thoughts of death and survival are both evolutionarily significant, and highly related.

Burns, et al.(2013) reasoned if survival processing leads to mortality salience, then dying scenarios that preclude survival processing should produce the same memory benefits as those produced by survival scenarios. In order to test this assumption, they constructed a dying scenario where participants were instructed to imagine being diagnosed as terminally ill with no hope of survival, thereby eliminating survival processing. Over the course of three experiments, they compared the dying scenario with the classic grasslands survival scenario as well as a pleasantness rating control group. They attempted to closely match the scenarios in terms of thematic structure, concreteness, and detail. Additionally, pilot tests were conducted to ensure the list items were equally matched for their relevance to each scenario. They found memory recall for death processing was equal to the memory recall for survival processing. Thinking about dying, without thoughts of survival, activates a recall advantage that is similar to the survival processing advantage. Therefore, their studies point to overlapping mechanisms between survival and death processing. In contrast, when Klein (2012) and Bell et al.

(2013) conducted a similar study, they found death scenarios did not produce memorial benefits to the same extent as survival scenarios. However, the researchers, did not control for word relevance or equate the death and survival scenarios in their studies, which casts doubts upon the soundness of their conclusions.

The Present Study

The association between survival processing and death processing, however, remains largely unexplored. The current study attempts to more thoroughly examine the relationship between survival processing and death processing. Specifically, the present study was designed to compare the effects of survival processing and death processing on the creation of false memories using the DRM paradigm to elucidate whether the proximate mechanisms underlying the two effects are similar. If the two are similar, then dying scenarios should produce false memories to the same extent as the survival scenarios.

Participants were randomly assigned to one of four groups: survival processing, death processing, moving or pleasantness. Both the moving and pleasantness groups were used as control conditions. Participants were shown DRM word lists, and depending on their randomly assigned group, they were instructed to rate the relevance of each DRM word to surviving, moving, or death, or to rate its pleasantness value. The rating scale used ranged from 1-4, with 1 being extremely irrelevant or unpleasant, and 4 being extremely relevant or pleasant.

Through an examination of item-gains, losses, and cumulative-recall curves the outcomes for the pleasantness and moving control conditions will be used to compare against both the survival and death processing conditions to determine the extent that participants utilize item-specific and relational processing while encoding words in the experimental conditions. Based on previous studies, the pleasantness rating control condition, which is known to induce item-specific processing of DRM list items, should cause a decrease in false memories. Therefore, if survival processing increases item-specific processing of the DRM list items, there should also be a decrease in the occurrence of false memories, and a pattern similar to the pleasantness rating control condition. If, on the other hand, survival processing increases relational processing of the DRM list items, then we would expect to see an increase in item-specific processing of the critical lures, and an increase in the prevalence of false memories. Further, if death processing has similar proximate mechanisms to survival processing, then participants' recall rates of false memories should be equivalent, and the cumulative recall curves should also be similar.

Method

Participants

Eighty-seven undergraduate students at Union College participated in this experiment. However, one participant's data was not used because they failed to follow the instructions to recall the words presented on the computer screen, and instead recalled the words presented on the PANAS scale. In exchange for their involvement, participants received either six dollars, or credit towards their introductory psychology or research methods course activities requirement. Participants were randomly assigned to one of the four groups, and they were tested individually in separate rooms. Sessions lasted for approximately forty-five minutes. Twenty participants were tested in the death and pleasantness conditions, twenty-one in the survival condition, and twenty-two in the moving condition.

Materials

DRM lists. Participants were presented with one long list that consisted of ten shorter lists composed of 10 words each (see Appendix A). All of the 10 words within each list were semantically related, for example, "bed, rest, tired and dream" moreover, all of the 10 words within each list centered on a word (the critical lure) that was not presented. In the example above, all of the words were related to the critical lure, sleep. A pilot study was conducted to ensure that the final list of items used were equally congruent to the survival, dying, and moving scenarios. In the pilot study, participants were instructed to rate list items selected from Roediger, Watson, McDermott, and Gallo's (2001) study for their relevance to survival, dying, and moving. Afterwards, the mean survival, dying, and moving rating, was computed for each word. Ten word lists containing ten words within each list were chosen based on the mean ratings such that overall the mean ratings for the three scenarios were nearly identical (Survival= 2.20, Death= 2.11, Moving= 2.18)

Design and procedure

A between-subjects design with the following conditions functioning as different levels of a single independent variable was used: death, survival, moving, and pleasantness. The four conditions differed with respect to the instructions they were read regarding the word rating task.

Participants were read one of the following sets of instructions:

Survival. ***"***In this task, we would like you to imagine you are stranded in the grasslands 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. We are going to show you a list of words, and we would like you to rate how relevant each of these words 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 four seconds to respond. Please try your best to respond before the four seconds are up.

After you have rated all of the words, the computer will ask you to wait for further instructions. When you see that message, please open the door to your cubicle.

Are there any questions?"

Moving. ***"***In this task, we would like you to imagine that you are planning to move to a new home in a foreign land. Over the next few months, you'll need to locate and purchase a new home and transport your belongings.

We are going to show you a list of words and we would like you to rate how relevant each of these words would be for you in this moving situation. Some of the words may be relevant and others may not. It's 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 four seconds to respond. Please try your best to respond before the four seconds are up.

After you have rated all of the words, the computer will ask you to wait for further instructions. When you see that message, please open the door to your cubicle.

Are there any questions?"

Pleasantness. "In this task, you will be shown a series of words 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 four seconds to respond. Please try your best to respond before the four seconds are up.

After you have rated all of the words, the computer will ask you to wait for further instructions. When you see that message, please open the door to your cubicle.

Are there any questions?"

Death. ***"***In this task, we would like you to imagine that you have been diagnosed as terminally ill, with no hope of surviving. Over the next few months, you'll need to give away your belongings, say good bye to loved ones, and find ways to ease your suffering. We are going to show you a list of words and we would like you to rate how relevant each of these words would be for you in this dying situation. Some of the words may be relevant and others may not. It's 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 four seconds to respond. Please try your best to respond before the four seconds are up. After you have rated all of the words, the computer will ask you to wait for further instructions. When you see that message, please open the door to your cubicle. Are there any questions?

All of the words were presented one at a time on the computer screen. They were presented in the same order for all participants, with each word shown for 4 seconds. Two practice words were included to make sure the participants had time to adjust to, and fully understood, the procedure. Participants were given no information regarding the upcoming recall task. Following the word-rating task, participants were given a packet. The first page of the packet was the positive and negative affect scale (PANAS), which was presented both to delay recall and to assess possible changes in affect resulting from exposure to the different scenarios. Participants were given a 2.5-minute distractor task (The PANAS), where they were given 20 words describing feelings or emotions and were told, to rate on a 1-5 scale the extent to which each word described how they were feeling at the\at moment.

Following the PANAS, participants were given a 10 minute long surprise recall task. They were told, “In a moment, I am going to ask you to remember and write-down as many of the words that you saw earlier on the computer screen as you can. These are the words you rated on the 1-4 scale, not the words you just rated on the piece of paper. Please be reasonably sure the word was presented before writing it down. You can write the words down in any order you like. You don't have to write them in the order they were shown. You will be given plenty of time to write-down the words. However, every so often, you will hear the tape recorder say, "Now draw a line". When you hear this message, please draw a line under the last word you just recalled, and then continue trying to recall more words. If you haven't recalled any new words since the last time you were asked to draw a line, then draw a second line under the last line. Are there any questions?" The recall task lasted 10 minutes.

Results

For each participant the PANAS produced a positive and negative affect score. The mean affect scores are presented in Table 1. The mean positive and negative affect scores were relatively consistent across the four conditions. A oneway between subjects analysis of variance (ANOVA) was conducted to examine the effects of the different levels of the independent variable: survival, death, moving, or pleasantness rating group on positive and negative affect. The ANOVA revealed no significant difference between conditions in positive affect or negative affect, F (3, 82) = 0.236, $p > .05$and F (3, 82) = 0.244, $p > .05$.

The total recall of list items, total recall of critical lures, and the total number of intrusions for each of the four conditions of the experiment are also displayed in Table 1. On average, the survival condition had the highest total recall of list items, followed by the moving, pleasantness, and death conditions. Those in the death condition had the highest number of false memories, followed by the moving, survival, and pleasantness groups. Further, the moving group had the greatest recall of intrusions, or words that were neither critical lures nor list items, followed by the death, survival, and pleasantness groups.

A one-way between subject ANOVA showed that there was no significant difference between conditions in the overall recall of list items, F (3, 82) = 0.238 p > .05. A significant difference was found between conditions in the overall recall of critical lures, F (3, 82) = 0.006, p > .05. Using the Tukey HSD test, post hoc comparisons revealed the death condition significantly differed from the pleasantness condition in the total number of false memories recalled. The survival and moving conditions did not significantly differ from the other conditions.

An analysis of cumulative recall scores to determine the type of processing participants in the various conditions performed on the recall scores is presented in Figure 1. The figure illustrates the curves for the pleasantness, moving, and death conditions were nearly identical. Further, the survival condition curve was considerably higher than the curves produced by the other groups, and diverged early in the recall period. This difference continued throughout the remainder of the ten minutes. As can be seen, the survival curve initially approaches the asymptote at a rapid rate for the first four minutes, before gradually tapering off for the remainder of the recall period.

An analysis of cumulative recall scores to determine the type of processing participants in the various conditions performed on the critical lures is presented in Figure 2. As can be seen, the death condition produced a curve higher than all other conditions. Moreover, the death processing and moving condition curves were the most similar initially with a rapid approach to the asymptote. Eventually, those in the moving condition began to recall slightly fewer items than those in the death condition. The pleasantness curve was the lowest; participants in this condition recalled the fewest false memories. Those in the survival condition produced slightly more false memories than those in the pleasantness condition, but considerably less than those in the moving, and death conditions. Both the survival and pleasantness conditions show slower, steadier curves throughout the recall period when compared with the moving and death conditions.

Discussion

The present experiment was designed to test whether rating words for their survival significance, death significance, moving significance, and pleasantness value would influence the formation of false memories utilizing the DRM paradigm. In particular, the study investigated whether death processing and survival processing share underlying mechanisms. It was predicted that if the two processes are similar, then participants in the survival and death conditions should recall a similar number of list items and critical lures. Cumulative-recall curves were assessed to analyze the extent participants used item-specific and relational processing while encoding the words in the various experimental conditions.

The results revealed no significant difference in positive or negative affect as a function of condition This finding suggests the rating tasks had no influence over the participants' emotional states. Therefore, the results cannot be explained in terms of participants' emotional reactions to the various scenarios they were presented.

The results did not replicate previous findings, specifically Nairne et al.'s (2007) original discovery, in which those placed into the survival-processing group experienced a memory enhancement effect. Although the survival group appeared to do better numerically than the other conditions with reference to the total number of list items recalled, the ANOVA produced no significant difference between conditions. Participants' memory systems were not more responsive to the encoding of words processed for their relevance to survival when compared with moving, pleasantness, and death conditions. If a larger sample size were used, the results may well have shown a significant difference between groups on the total number of list items recalled, and would have provided additional support for the memorial benefits brought about by survival processing.

The cumulative recall of list items showed that participants given the survival scenario had numerically greater recall than those in the moving scenario. Moreover, the results are also consistent with Burns et al.'s (2011) discovery that survival-rating tasks produce significantly higher curves than pleasantness-rating tasks.

As can be seen in Figure 1, during the first four minutes of recall, the steep initial slope of the recall curve for the survival group implies more relational processing was occurring relative to the other conditions. Overall, the death, moving, and pleasantness conditions produced nearly identical recall curves. Following the first four minutes, all four groups tended to recall the same amount during each minute, suggesting all groups performed an equivalent amount of item-specific information. This finding is consistent with Burns, et al.'s (2011) proposal that survival processing is superior to control conditions that elicit either item specific or relational processing because survival processing utilizes both item specific and relational processing during the encoding of stimuli. Based on the current study, the traditional memory advantage conferred by survival processing, to the extent that it occurred, may be due to a combination of both item specific and relational processing. These findings also imply dying and survival scenarios do not result in similar underlying processes or mechanisms.

The results clearly contradict the Burns, Hart and Kramer (2013) finding that dying scenarios precluding survival processing produce memorial benefits to the same extent as survival scenarios. In the present study, the death condition produced the lowest average total recall of list items, which was lower than both the moving and pleasantness control conditions (Table 1). Therefore, processing words for their relevance to dying does not appear to lead to memory improvements. It is not clear why the present study failed to replicate previous findings. One possible reason for failing to replicate the finding that death processing improves recall as much as survival processing is that in previous studies words were unrelated to each other, whereas in the present study the DRM words were related.

The results of the present study were consistent with Klein's (2012) study, which found the survival scenario produced the highest numerical recall, while the dying scenario produced lower recall that was most similar to the pleasantness scenario recall. Arguably, Klein's findings may have been inaccurate because he failed to control for word congruity. Word congruity is the finding that words given higher scores are remembered better than words given lower scores on rating tasks. Therefore, although word ratings were not analyzed for the current study, if the ratings had been the same across the different groups then this similarity could explain the inability to replicate previous studies that have found no difference in recall levels between survival and dying scenarios.

Although the results showed no significant difference, the survival condition appeared to produce more false memories than the pleasantness condition, but fewer false memories than both the moving and death conditions. Thus, Otgar and Smeets' (2010) and Howe and Derbish's (2010) findings that survival processing increases the prevalence of false memories were not replicated in the current study.

Interestingly, those in the death condition significantly differed from those in the pleasantness control condition by producing the highest number of falsely recalled items or critical lures. Thus, death processing in my study behaved in a similar manner to survival processing in the Otgaar and Smeets (2010) and Howe and Derbish's (2010) study.

Evolutionary theory has the potential to explain this novel finding. When humans first attained the ability to understand time, they began engaging in activities that would benefit future survival, such as planting crops and establishing permanent settlements. When there is anticipation and awareness of future events, resources are used with future survival in mind. On the other hand, when the future appears uncertain, or bleak, limited resources are invested for future endeavors. The mind may act in a similar manner. When there is no hope for the future, which is what the participants in the death scenario were instructed to imagine, there is no need to allocate cognitive resources to accurately take in and thoroughly process incoming data. Those in the mortality salience group might have reserved more mental energy when compared with the other groups when engaging in the rating task, which could cause the increase in falsely recalled items. (Of course, whereas this explanation accounts for my findings, it does not explain previous findings of greater false memories following survival processing.)

If false memories may be understood according to fuzzy trace theory, then those in the death condition, because of the reduction in cognitive resources allocated to the present task, might have encoded a less detailed initial trace, which could explain the increase in false memories. In terms of source monitoring theory, when the information was initially encoded for those in the death processing condition, the basis for the information (either internal or external) would be less likely to be recorded in memory because of the lower mental resources allocated to the task, and therefore individuals would have been more likely to perceive the information as externally generated, leading to an increase in the recall of the critical lures.

According to these explanations, however, the death group should have produced the lowest recall of actual list words. Thus, these speculations cannot explain the finding that the death group produced the highest recall of actual list words.

An additional anomaly that could explain the inability to replicate previous findings is the group standard deviations for the recall scores of the present study were quite large relative to typical recall standard deviations. Standard deviations for the recall of list items for survival, dying, pleasantness, and moving were: 9.10, 7.04, 10.75, and 6.99 respectively. The high variability among participants' recall scores suggests participants might have approached the task using different techniques, or some might have been more serious than others to cause the large standard deviations. In the future it would be interesting to expound on the relationship between death processing and the generation of false memories. Further research is necessary to elucidate the robustness of the effect.

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Table 1.

Mean Performance Measures as a Function of the Type of Rating Task

	Survival		Dying		Pleasantness		Moving	
Performance Measure	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Positive Affect	2.70	0.55	2.69	0.68	3.03	0.75	2.69	0.55
Negative Affect	1.38	0.26	1.54	0.59	1.27	0.26	2.69	0.55
Total Recall List items	33.20	9.10	28.29	7.04	28.65	10.75	29.72	6.99
Total Recall Critical Lures	1.55	1.19	2.46	1.56	1.20	0.70	1.91	1.06
Total Recall Intrusions	1.65	2.03	2.83	3.34	0.70	0.57	3.73	4.07

Figure 1. Mean cumulative number of list items recalled correctly as a function of the type of rating task.

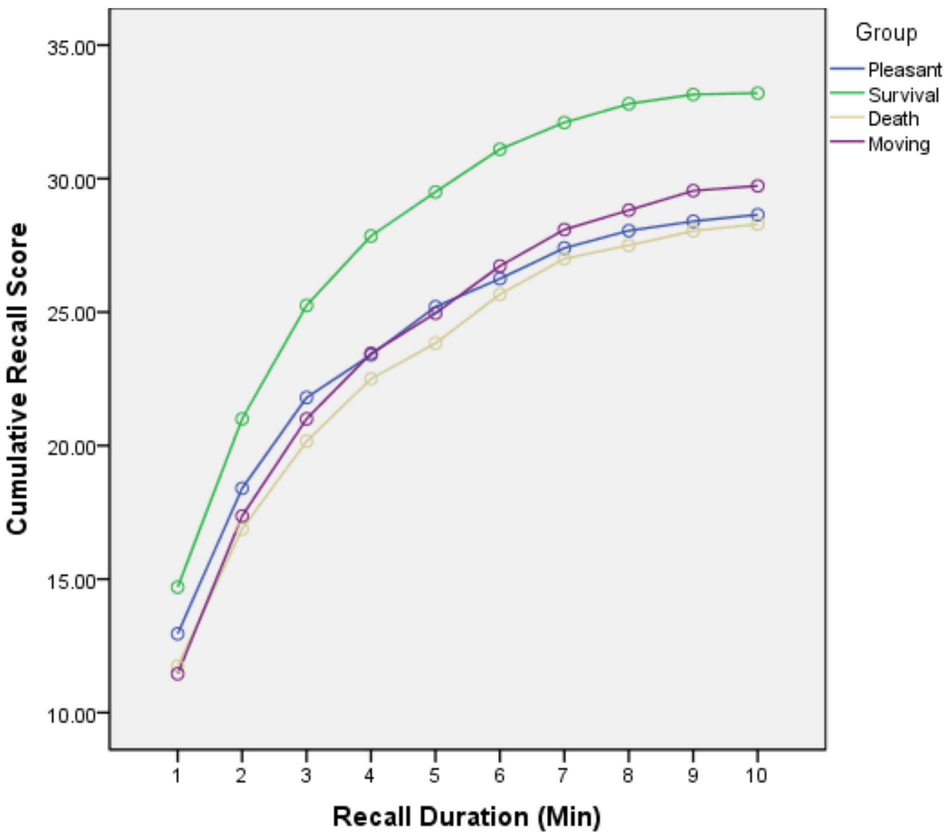
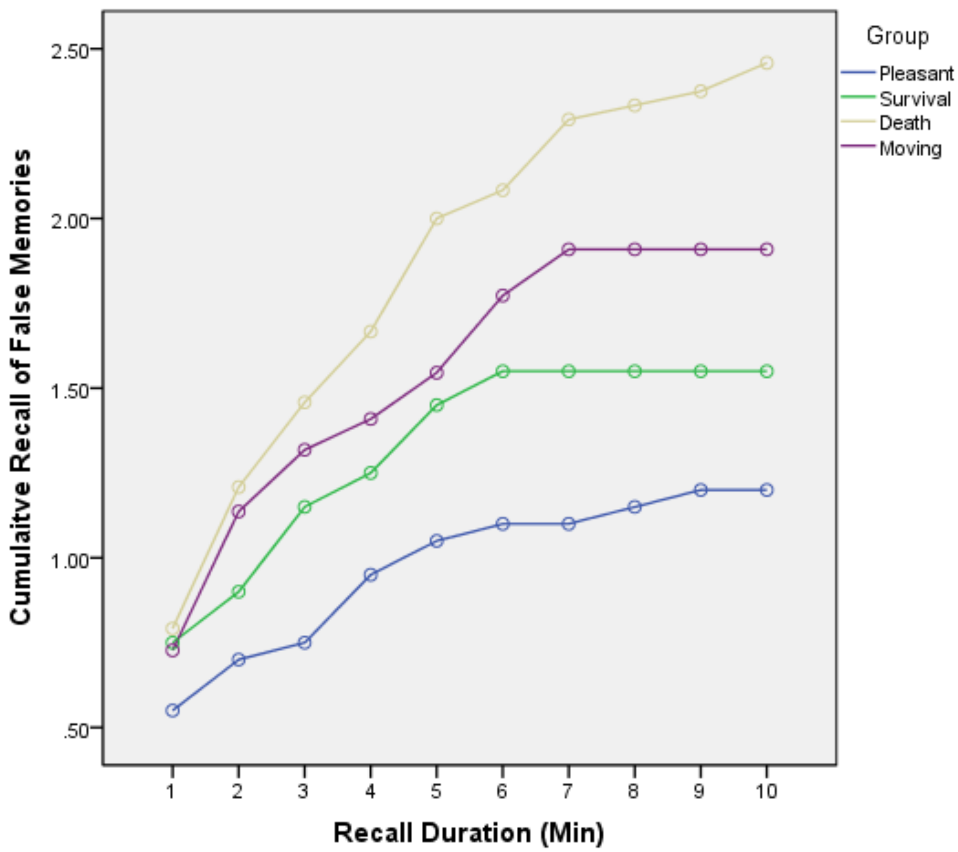


Figure 2. Mean cumulative number of items recalled correctly as a function of the type of rating task.



Appendix I

List words used in the present experiment in the order they were presented to participants.Words in bold are critical lures.

Sleep	**Smell**	**Flag**	**Beautiful**
bed	rose	freedom	ugly
rest	nose	pendant	pretty
tired	hear	symbol	girls
dream	see	stars	woman
wake	whiff	anthem	picture
blanket	scent	stripes	lady
slumber	reek	raised	snow
snore	stench	national	scene
nap	fragrance	checkered	gorgeous
peace	perfume	emblem	day

Butterfly	**Music**	**Soft**	**King**
moth	rhythm	light	Queen
wing	note	pillow	England
bird	sound	plush	Crown
fly	sing	loud	Prince
yelllow	band	cotton	Dictator
flower	melody	fur	Palace
cocoon	horn	touch	Throne
summer	concert	fluffy	Chess
color	instrument	skin	Rule
worm	art	tender	Subjects

Mountain	**Girl**
hill	boy
valley	female
climb	young
top	dress
molehill	hair
peak	niece
plain	dance
glacier	aunt
climber	daughter
ski	sister