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Survival Processing Does Not Improve Paired-Associate Learning

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In a variety of nonhuman species, there is evidence to support the notion that memory systems have evolved to allow species to adapt to particular niches (Adachi, Chou, & Hampton, 2009; Sherry & Schacter, 1987). It is therefore logical to suspect that human evolution has shaped our memory processes, given the range and power of human memory systems (Nairne & Pandeirada, 2008). Evolutionary processes are difficult to address in studies of human cognition because cognition does not leave fossils, nor can contemporary cognitive psychologists use any aspect of natural selection as an independent variable in experiments. Thus, evolutionary psychology requires research to look at variables that may have been shaped by natural selection in the distant past and to examine how they affect memory in modern humans. To accomplish this, research must be creatively designed to examine the effects of memory variables that might have influenced the evolution of human memory.

One such methodology of evaluating possible evolutionary effects on memory is the survival processing paradigm, developed by James Nairne and his colleagues. In the seminal study, Nairne, Thompson, and Pandeirada (2007) asked participants to rate a list of unrelated words in terms of their relevance to surviving in the grasslands of a foreign land. Participants were later given a free recall test for the unrelated words. Nairne et al. found that participants who made survival-relevance judgments recalled more words on a free recall test than did participants instructed to use other well-established encoding techniques, such as making pleasantness judgments or judging the words in terms of self-relevance. Other researchers have shown survival processing to produce better free recall than other scenarios, such as moving to a new house, planning for a bank robbery, and even surviving in a hostile city (Butler, Kang, & Roediger, 2009; Kang, McDermott, & Cohen, 2008; Kostic, McFarlan, & Cleary, in press; Nairne & Pandeirada, 2011; Nairne, Pandeirada, & Thompson, 2008; Seamon et al., 2012; Weinstein, Bugg, & Roediger, 2008).

Nairne and Pandeirada (2010) suggested that survival processing is likely the result of a memory module tuned to ancestral conditions. That is, embedded in our cognitive architecture are mechanisms that are tuned specifically to those stimuli that are related to survival in our ancestral environment. For a prehistoric human, remembering information vital to survival may have led to natural selection for this ability. If natural selection is applicable to memory abilities, we should see evidence of it in memory in modern humans. Nairne and Pandeirada reason that modern stimuli that most closely match this ancestral tuning will be remembered better than those that match less closely.

If this argument is correct, then the advantages of survival processing should be seen across various tests of memory and should not be restricted to the specific methodology employed by Nairne and Pandeirada in their various experiments (see Nairne & Pandeirada, 2011). That is, if an evolutionarily based survival memory system exists, it ought to be observable across many situations in which information is cast against a survival background. Therefore, we should see survival processing effects in many different scenarios that call on mnemonic processing, in both incidental and intentional learning, and with a variety of memory tests. In the current study, we examined the effects of survival processing on paired-associate learning with both incidental and intentional learning.

We choose paired-associate learning for three reasons. First, to our knowledge, survival processing had not yet been tested with paired associates when we started the project (but see Seamon et al., 2012). Associative learning is a major form of human learning, presumably shaped by natural selection (Platt, Brannon, Briese, & French, 1996). Because so much of human memory is cue-dependent (e.g., Tulving & Pearlstone, 1966), it is important to examine if survival processing is effective in memory situations that call on cue–target associations. Second, paired-associate learning is frequently used in memory experiments and clearly benefits from elaborative processing, such as pleasantness judgments and imagery instructions (Wang & Thomas, 1995). If survival processing has the generalizability expected if it is an evolutionary module, we should see its effects in cued recall tests of paired associates as well as free recall of items from unrelated lists. Third, we can design experiments that are identical except for one respect, whether or not the participants know if their memories will be tested. That is, in one condition, we can tell people to focus on the survival processing task because we are interested in those judgments without making any reference to a later memory test. In another condition, we can inform the participants that a memory test will follow. Thus, we can examine intentional versus incidental learning.

On another level, paired-associate learning models many forms of real-world learning, such as learning vocabulary in a new language and learning difficult words for standardized tests (Kornell, 2009). If paired-associate learning benefited from survival processing, there would be clear practical implications of survival processing research. We could encourage students and other learners to employ survival processing when engaged in learning activities.

To date, only one other experiment has examined survival processing manipulations with a cued recall test. Seamon et al. (2012) presented participants with a 14-paragraph story read by an experimenter. Participants were instructed to make a survival-relevance judgment or a meaning-relevance judgment for each paragraph in the story. Following the presentation of the story, the participants answered cued-recall questions concerning factual information in the story. Seamon et al. found no evidence that the survival-relevance judgments led to greater levels of correct cued recalls than did the meaning-relevance judgments. Indeed, performance was equal to that when evaluating the meaning relevance of the story. Thus, the Seamon et al. data add to the recent spate of studies finding limitations to the extent to which survival processing generalizes (e.g., Soderstrom & McCabe, 2011; Tse & Altarriba, 2010).

In our paradigm, participants make specific judgments on discrete paired associate items, so we contend that our paradigm more closely matches the Nairne paradigm than Seamon et al. (2012). To examine paired-associate learning, we used language translation equivalents in Swahili–English (Experiments 1 and 2) and Lithuanian–English (Experiments 3 and 4). Participants encoded the pairs using survival processing or other instructions, such as pleasantness judgments. Later, a cued-recall test was administered in which the new-language word was presented and participants were asked to recall the English translation.

The current study was designed with two goals in mind. First, we wished to determine if survival processing improves the memory for paired associates in a language learning paradigm, tested by cued recall. Our initial hypothesis was that survival processing would benefit paired-associate learning. Given the proposed mechanisms for the survival processing effect in free recall, it should generalize to other kinds of learning and memory testing (Nairne & Pandeirada, 2008). However, as will be seen shortly, we found no evidence to support this hypothesis. In Experiments 2, 3, and 4, we were also interested to see if survival processing would affect meta-memory judgments for unrecalled items. We looked at both feeling-of-forgetting judgments (Halamish et al., 2011) and feeling-of-knowing judgments (Thomas, Bulevich, & Dubois, 2011) to examine meta-memory judgments. If meta-memory judgments are sensitive to variables that affect memory, the judgments would be sensitive to survival processing as well. However, some research suggests that meta-memory judgments are sensitive to cues that are linked with memorability but are not linked directly to memorability itself (e.g., Koriat, 1993). Thus, the inclusion of the meta-memory judgments allowed us to determine if meta-memory judgments are sensitive to survival processing or if our meta-memory is not attuned to this factor (Palmore, Garcia, Bacon, Johnson, & Keleman, 2012).

EXPERIMENT 1

Experiment 1 was conducted as a preliminary experiment, exploring the application of survival processing and paired-associate learning. We conducted it in a large classroom of students in an undergraduate Psychology class. As such, all students received the same list of words in an identical order, though the order itself was created randomly. This creates a confound with order effects but also allowed us to test many participants.

Method

Participants

A total of 138 Florida International University students participated in the first experiment in return for research credit. This and all experiments described here were approved by Florida International University's Institutional Review Board (IRB).

Materials and Procedure

A total of 20 Swahili words, each paired with their English translation, were shown on PowerPoint slides from a screen in the middle of a class auditorium. The Swahili words used for Experiments 1 and 2 were chosen from the Nelson and Dunlosky (1994) norms and were of moderate difficulty. All participants were run simultaneously in a large auditorium. The experiment was a between-subject design with three levels (pleasantness judgments, savannah-survival judgments, and city-survival judgments).

The experimenter (BRB) introduced the experiment and distributed informed consent forms to each participant. He then asked them to participate in a memory experiment and told them they would view translation pairs in a PowerPoint presentation. He then distributed instruction sheets concerning how each participant was to encode the stimuli. Each participant read instructions that were given on individual sheets of paper. The participants were randomly assigned to one of the three different conditions, which were adapted from Kang et al. (2008). Participants did not discuss their instructions with each other or recall collaboratively. The conditions were as follows:

> *Word pleasantness*. "I am going to show you a list of word pairs on a PowerPoint slide show. Each slide will display a single word in Swahili on the left side, and its English translation on the right side, for 5 seconds. Your task is to rate the pleasantness of each word (on a scale of 1 to 5; 1 being very unpleasant and 5 being very pleasant) Some of the words on these slides may sound or look pleasant to you while some words may not—it is up to you to decide."
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> *Survival—grassland setting*. "Imagine as best as possible that you are stranded in foreign grassland, such as the plains of Africa. You are the only one in this environment and you have no survival materials. Over the course of a few months, you will need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of word pairs on a PowerPoint slide show. Each slide will display a single word in Swahili on the left side, and its English translation on the right side, for 5 seconds. Your task is to rate how relevant each of these words would be for you in this survival situation (on a scale from 1 to 5; 1 being barely relevant and 5 being highly relevant). Some of the words on these slides may be relevant and some may not—it is up to you to decide."
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> *Survival—city setting*. "Imagine as best as possible that you are stranded in a foreign city. You are the only one in this environment and you have no survival materials. Over the course of a few months, you will need to find steady supplies of food and water and protect yourself from attackers. We are going to show you a list of word pairs on a PowerPoint slide show. Each slide will display a single word in Swahili on the left side, and its English translation on the right side, for 5 seconds. Your task is to rate how relevant each of these words would be for you in this survival situation (on a scale of 1 to 5; 1 being barely relevant and 5 being highly relevant). Some of the words on these slides may be relevant and some may not—it is up to you to decide."

After reading instructions, we showed participants a list of 20 Swahili words and their English translation. Each word pair was shown for 5 seconds. During this time, we instructed the participants to rate each word pair's relevance (according to their particular condition) on a Likert scale with values from 1 to 5. After the participants had seen all 20 words, we showed the list again in the same order, with each word being visible for 3 seconds. Ratings were made during the second presentation as well. Following the second trial of learning, participants engaged in an arithmetic task for 5 minutes to prevent rehearsal. Following the 5-minute distractor task, the participants received a recall test. The participants were shown a slide with a Swahili word on the overhead screen and were instructed to write down the English translation on the answer sheet we provided to them. The order at recall was randomly selected and was different from the order of presentation during learning. The recall sheets were collected from each participant, and then finally the participants were debriefed and thanked for their participation.

Results

Participants' mean ratings did not differ across conditions, $F < 1$. The mean pleasantness was 3.1, the mean grassland-survival rating was 2.9, and the mean city-survival rating was 2.8. The mean difference in rating hovered around 3.0 for both pleasantness and survival in Experiments 2 through 4 as well and therefore will not be reported further for the sake of brevity.

We did not find any recall advantage of the grasslands scenario relative to the other conditions, $F < 1$. The mean level of recall was 21 percent in the pleasantness condition, 21 percent in the grasslands-survival condition, and 18 percent in the city-survival condition. Subsequent analyses found a congruity effect (e.g., Butler et al., 2009). Words that were rated high (above the mean) on survival relevance were more likely to be remembered in the survival processing condition than words that were rated less high on survival relevance. Congruity effects are common in survival processing experiments (see Palmore et al, 2012).

Discussion

We initially expected the survival processing conditions (grasslands) to produce better recall than the control conditions. However, we found no differences. Before drawing any conclusions, we were concerned about a number of factors in this experiment. First, because all participants received the same order of the same stimuli, we were concerned that order effects may have swamped any survival processing effect. Thus, in subsequent experiments, we tested participants on an individual basis and randomized the order of presentation during encoding and during testing. Second, students were aware that a memory test would follow. Therefore, they may have ignored our instructions and used their own study strategies. As a result, in all subsequent studies, we focused participants' attention to the instructional tasks but did not inform them that a memory test would ensue.

EXPERIMENT 2

In Experiment 2, we tested participants individually. We did not give participants instructions that memory would be tested after they finished rating the pairs. In this way, at least instructionally, the experiment involved incidental learning. In addition, we were originally interested in testing how different processing scenarios would affect meta-memory judgments. We anticipated that survival processing would lead to better recall, but that participants would not show metacognitive awareness. In fact, in Experiment 2, we found the opposite pattern.

Method

Participants and Materials

A total of 61 Florida International University students participated. All of these participants were Introductory Psychology students and did not overlap with the participants involved in Experiment 1. We used the same Swahili–English word pairs as we used in Experiment 1.

Procedure

The experiment was a between-subject design with two levels (pleasantness judgments and savannah-survival judgments).

Participants were tested individually on Macintosh computers. We randomized the order of presentation for all participants during both encoding trials and at the time of retrieval. On arriving at the lab, each participant was randomly assigned to the survival processing condition (30 participants) or the pleasantness judgment condition (31 participants). Participants then read the instructions to evaluate each translation pair either in terms of its pleasantness or in terms of whether or not the concept represented by the pair would be useful to survival. Participants were instructed to evaluate the word pairs in terms of survival processing or pleasantness ratings but were not informed that there would be a subsequent memory test. The instructions were as follows.

> *Survival processing*. "You will be presented with a short series of Swahili words and their translation in English. The Swahili word will be presented on the left and its translation on the right. In this task, please imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. You have recently received word that a dangerous predator has been seen in the area. You will need to avoid and/or escape from the predator to ensure your survival. You will see each word pair for 10 seconds. During that time, think how relevant each of these word pairs would be in your attempt to avoid the predator."
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> *Pleasantness judgments*. "You will be presented with a short series of Swahili words and their translation in English. The Swahili word will be presented on the left and its translation on the right. Some of the words may be pleasant in meaning, sound, or appearance, and some may not. Please evaluate each word in terms of its pleasantness as you read each pair. You will see each word pair for 10 seconds. During that time, think about whether or not the word pair is pleasant or unpleasant."

After reading instructions, we showed participants a list of 20 Swahili words and their English translation. Each word pair was shown for 10 seconds. During this time, the participants were instructed to rate each word pair's relevance (according to their particular condition) on a Likert scale with values from 1 to 5. After the participants had read all 20 words, we showed the list again in a new random order, with each word being visible for 10 seconds. Participants made ratings again during the second presentation.

Following the second trial of learning, participants were given instructions concerning recall. They would again see the Swahili word, and we instructed them to recall the English translation. We discouraged participants from guessing and told them to type in an answer only if they were fairly confident that they were correct. They were then shown the Swahili cues in a random order and asked to recall the English translation. If they knew the English word, they typed it in. If they did not, we asked them if they had learned the word and forgotten it (henceforth, a feeling-of-forgetting judgment). The participants were then given a recognition test for unrecalled items. For the recognition test, the Swahili word was again presented, followed by four alternatives. All four of the alternatives were English words used as targets in the experiment, one of which was the correct translation. This means that each target word was used four times in the experiment, three times as a distractor and once as a target. This meant that participants could do some process of elimination in recognition. However, the recognition test showed no effects of survival processing and was mainly included to assess the accuracy of the meta-memory judgments.

Results and Discussion

Participants recalled more words in the pleasantness judgment condition (34 percent) than in the survival processing condition (20 percent), $t(59) = 2.02$, $p < .05$ (Fig. 9.1).

In this experiment, we found a statistically significant advantage in cued recall for those items that had been encoded with pleasantness judgments over survival

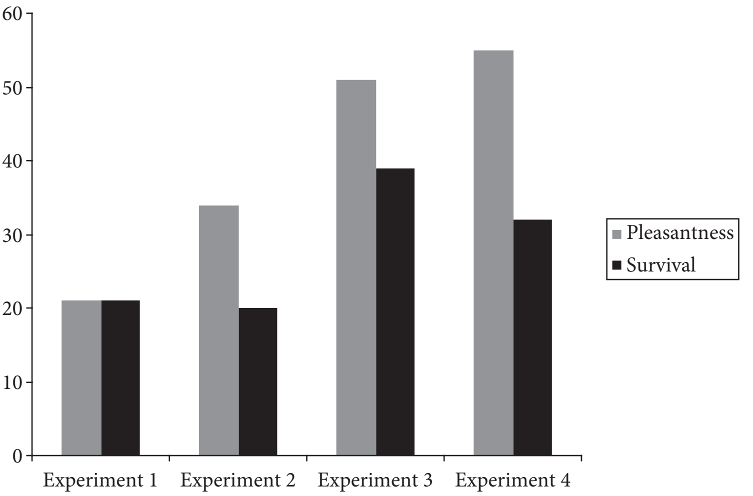

Figure 9.1 Mean recall as a function of survival processing vs. pleasantness judgments in Experiment 1, 2, 3, and 4.

processing in this experiment. Because in this experiment we tested participants one by one with order randomized for each participant, the effect cannot be dismissed as an order effect. Moreover, because the instructions did not specify that memory would be tested later, we also followed the usual survival processing procedures in which encoding is incidental, thus following the original paradigms of Nairne et al. (2007). However, what we found was a reverse survival processing effect: survival processing led to *worse* memory than the pleasantness judgments.

We also found that for unrecalled items, feeling-of-forgetting judgments were higher in the survival processing condition than in the pleasantness judgment condition, $t(59) = 2.04$. However, this effect did not replicate in the next two experiments, so we report it here only to be thorough. Recognition of unrecalled items was not affected by the experimental manipulation ($t = 1.2$). The overall mean recognition was 52 percent.

In this experiment, we found that pleasantness judgments instructions led to cued-recall advantages compared to survival processing instructions. Because few studies have shown that survival processing led to a deficit in performance (but see Klein, Robertson, & Delton, 2011), because the effect size was quite small, and because we wondered if including the feeling-of-forgetting judgments might have altered the manner in which participants approached retrieval, we conducted a replication in Experiment 3. In this experiment, we used a condition with meta-memory judgments and another condition without meta-memory judgments.

EXPERIMENT 3

Experiment 3 involved a conceptual replication of Experiment 2. The differences were that we used new stimuli, Lithuanian–English pairs instead of Swahili–English pairs. This allowed us to determine if the negative survival processing effect would replicate with other materials. Experiment 3 was identical in other ways to Experiment 2. In Experiment 3, we tested to determine if including the meta-memory judgments was affecting recall of the targets. Thus, in Experiment 3, we included one condition in which we included meta-memory judgments and a recognition test and we included one condition in which we did not include either the feeling-of-forgetting judgments or the final recognition test.

Method

Participants and Materials

A total of 124 Florida International University students participated. In this experiment, we switched from the Swahili–English pairs to Lithuanian–English translation equivalents, drawn from the norms of Grimaldi, Pyc, and Rawson (2010). Twenty-one translations were chosen from the top of the list in Appendix A of Grimaldi et al. (2010). In Experiments 1 and 2, our lists were 20 words long, but in this one we used a 21-word list.

The experiment was a between-subject design with two levels (pleasantness judgments and savannah-survival judgments). We also compared the presence or absence of feeling-of-forgetting judgments as a second between-subject variable.

Procedure

The procedure for Experiment 3 was identical to Experiment 2, except for the stimuli. We also ran a condition in which we did not ask for feeling-of-forgetting judgments or recognition of unrecalled items.

Results and Discussion

In Experiment 3, participants recalled more words in the pleasantness judgment condition (52 percent) than in the survival processing condition (40 percent), $t(58) = 2.02$, $p < .05$ (see Fig. 9.1). When feeling-of-forgetting and recognition were not collected, participants recalled more words in the pleasantness judgment condition (50 percent) than in the survival processing condition (37 percent), $t(62) = 2.68$, $p < .05$ (see Fig. 9.1).

It is also worth noting that the Lithuanian–English translations were easier to learn than the Swahili–English translations.

In Experiment 3, the instruction manipulation did not affect the magnitude of the feeling-of-forgetting judgments made on unrecalled paired associates, $t = 0.67$. Recognition of unrecalled targets did not differ between the conditions, $t = 1.21$. The overall recognition level was 55 percent.

EXPERIMENT 4

Experiment 4 was methodologically similar to Experiment 3 with one exception: we used a standard meta-memory measure, feeling-of-knowing judgments, instead of a nonstandard measure, feeling-of-forgetting judgments. Because most studies do not use feeling-of-forgetting judgments, we were not convinced that participants understood them in the way we intended. Thus, we switched to the more standard measure.

Method

Participants, Materials, and Procedure

A total of 61 Florida International University students participated. The method was identical to Experiment 3 except that participants made feeling-of-knowing judgments instead of feeling-of-forgetting judgments. The experiment was a between-subject design with two levels (pleasantness judgments and savannah-survival judgments).

Results and Discussion

In Experiment 4, participants recalled more words in the pleasantness judgment condition (55 percent) than in the survival processing condition (32 percent), $t(59) = 3.70$, $p < .05$ (see Fig. 9.1).

In this experiment, the instruction manipulation did not affect the magnitude of the feeling-of-forgetting judgments made on unrecalled paired associates, $t = 1.78$. Recognition of unrecalled targets did not differ between the conditions.

GENERAL DISCUSSION

Our initial hypothesis was incorrect: survival processing does *not* benefit learning of paired associates. In all of the experiments, survival processing did not result in benefits to learning relative to all other conditions. However, in four experiments, we found that pleasantness judgments led to better recall of paired associates than did survival processing judgments. In the first two experiments, we used Swahili–English translation pairs, and in the last two experiments, we used Lithuanian–English word pairs. It did not matter; for both sets of stimuli, pleasantness judgments led to better recall than did survival processing judgments (see Klein et al., 2011, for similar findings).

These findings are consistent with several recent findings of limited generalizability to the survival processing paradigm. For example, Tse and Altarriba (2010) showed that survival processing did not increase the sensitivity of items to implicit memory tests relative to control items. Burns, Hwang, and Burns (2011) found that survival processing was mostly eliminated for categorized lists (but see Otgaar & Smeets, 2010). Palmore et al. (2012) found that when congruity effects were accounted for, judgments of learning were not sensitive to survival processing. Savine, Scullen, and Roediger (2011) found that survival processing does not benefit the learning of faces (but see Otgaar, Smeets, & van Bergen, 2010, for positive results with other visual stimuli). Seamon et al. (2012) found that meaning-relevance instructions resulted in the same memory performance as survival-relevance instructions. Finally, Klein et al. (2011) found that processing for future planning led to better recall than survival processing. Our finding that survival processing does not affect paired-associate learning adds to this list. Thus, there is a growing surge of research that replicates the basic survival processing effect but finds that it does not generalize greatly beyond its initial scope (i.e., Nairne et al., 2007), much of it reviewed in the chapters in this volume.

We assert that the limited generalizability of survival processing argues against its inclusion as a set of cognitive modules shaped by natural selection. Indeed, Klein et al. (2011) have argued that "survival" itself is too broad a term to think of in terms of natural selection. That is, natural selection favors those traits that do survive, not whether those traits concern survival. This has led other researchers to search for more specific evolutionarily based mechanism, such as planning for the future (Klein et al., 2011) or learning relevant social information (Klein et al., 2009). In the current context, if remembering survival-relevant information were shaped by natural selection, one would expect its benefits to include many situations in which people are considering material in terms of its relevance to survival. Therefore, what can best explain the survival processing effect?

Burns et al. (2011) looked at the proximate mechanisms that cause the survival processing effect. They found that survival processing led to the use of both item-specific and relational processing while encoding words. When they manipulated conditions, such that other encoding conditions also benefited from both item-specific and relational processing, the advantages of survival processing over those conditions disappeared. Thus, Burns et al.'s data suggest that survival processing advantages may simply reflect the combined use of two processing strategies, and that other paradigms, such as learning faces or learning paired associates, may also draw on both processing strategies, thereby eliminating the advantages that survival processing might have over other learning strategies.

What then drives the reverse survival processing effect observed here? Following Burns et al. (2011), we suspect that survival processing leads to the increased use of relational processing across items in free recall of word lists. That is, it helps participants construct stories to connect items together. However, in the current studies, using cued recall, relational processing across items is not relevant. What is important is meaning-based associative processing between the novel item (the word in Swahili or Lithuanian) and its familiar translation equivalent. In this case, what benefits encoding are processes that create that associative processing between the items. Pleasantness judgments may focus learning on associating the items, whereas survival processing may focus the learning on relations among items. Thus, it is possible that we would have found a survival processing effect if we had asked participants to free recall English translations (or Swahili or Lithuanian words) rather than recall specific English words when presented with specific other-language words.

Human beings are biological organisms, and human cognition is a function of biological processes in the human brain. So it is certain that human cognition evolved in the distant past. However, what the processes were that drove human cognition are still poorly understood (Klein et al., 2009), and how those processes affect memory performance in modern populations is likely complex and difficult to study. We applaud Nairne and colleagues (e.g., Nairne & Pandeirada, 2011) for attempting to crack this difficult nut. However, it does not seem that the survival processing effect in free recall of single-word lists is necessarily a paradigm that will shed light on how natural selection drove the evolution of human memory. Nonetheless, we are optimistic that the study of the adaptive nature of human memory will blossom and will eventually lead us to both better questions and better answers.

AUTHORS' NOTE

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