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The future-orientation of memory: Planning as a key component mediating the high levels of recall found with survival processing

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In a series of papers, Nairne and colleagues have demonstrated that tasks encouraging participants to judge words for relevance to survival led to better recall than did tasks lacking survival relevance. Klein, Robertson, and Delton (2010) presented data suggesting that the future-directed temporal orientation of the survival task (e.g., planning), rather than survival per se, accounts for the good recall found with the task. In the present studies we manipulated the amount of survival and planning processing encouraged by a set of encoding tasks. Participants performed tasks that encouraged processing stimuli for their relevance to (a) both survival and planning, (b) planning, but not survival, or (c) survival but not planning. We predicted, and found, that recall performance associated with tasks encouraging planning (i.e., survival with planning and planning without survival) should exceed tasks that encouraged survival but not planning (i.e., survival without planning). We draw several conclusions. First, planning is a necessary component of the superior recall found in the survival paradigm. Second, memory, from an evolutionary perspective, is inherently prospective—tailored by natural selection to support future decisions and judgements that cannot be known in advance with certainty.

Keywords: Memory; Evolution; Time.

Memory, from an evolutionary point of view, is inherently prospective: It enables its possessor to behave more appropriately (that is, adaptively) at a later date by using information acquired in the past. Accordingly, the longstanding focus in memory research on one end of the temporal spectrum (an organism's ability to recall the past) unintentionally downplays the future-orientation of memory for dealing with current circumstances and anticipating future contingencies that cannot be known in advance with certainty. Since events that transpired in the past have already had their effect on our ability to survive and reproduce, the mere capacity to recollect their occurrence is of limited benefit to the organism's reproductive fitness (although, under certain circumstances, such recollection has important fitness consequences—for reviews and discussion, see Klein, 2007; Klein, Cosmides, Tooby, & Chance, 2002; Klein et al., 2009; Suddendorf & Corballis, 1997). By contrast, there would be fitness benefits from a memory system designed to take past events and extract information from them that increases our ability to deal with the current situation and aids planning for future contingencies (i.e., the ''now and the next'').

More than a century ago, the philosopher, F. N. Bradley (1887) summarised many of these ideas

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with the following observation (pp. 581–582; word in parentheses added for textual clarification):

> Why is our memory directed towards our incoming sensations and towards the (temporal) side from which change comes? . . . The answer, in a word, is practical necessity . . . Life being a process of decay and of continual repair and struggle throughout against dangers, our thoughts, if we care to live, must mainly go the way of anticipation. We are concerned practically with what meets us and what we go to meet, and this practical concern has formed the main habit of our thought.

Nonetheless, the vast majority of contemporary research still maintains a focus on understanding memory's part in one aspect of the temporal spectrum—our ability to recollect experiences from the past—while devoting far less attention to its central role in our ability to plan for and anticipate future contingencies (for a more extended discussion, see Klein et al., 2010).

Researchers adopting an evolutionary perspective take as a starting assumption that systems exist in their present arrangement because that form solved certain recurrent problems the organism faced in its evolutionary history, and attempt to use knowledge of those problems to reverse-engineer the design of the systems (e.g., Barkow, Cosmides, & Tooby, 1992: Dawkins, 1976; Glenberg, 1997; Klein, Cosmides, et al., 2002; Nairne, 2005; Sherry & Schacter, 1987; Suddendorf & Corballis, 1997; Williams, 1966). From this perspective, memory can be viewed as the result of the complex interplay of a set of processes that enable the organism to draw on past experiences to guide current behaviour and plan for future contingencies (for discussion, see, Adam, 2004; Boyer, 2007; Bradley, 1887; Ingvar, 1985; Klein, 2007; Klein, Cosmides, et al., 2002; Klein et al., 2009, 2010; Llinas, 2001; Suddendorf & Corballis, 1997; for a differing opinion, see Jones & Paschler, 2007). To the extent that these abilities affect the organism's reproductive potential they are acted on by natural selection.

In a recent paper (Klein et al., 2010) we provided evidence for the ''future-orientation of memory'' by demonstrating that when an encoding task required participants to consider the relevance of a set of stimuli for a specified future contingency (i.e., planning for future needs), subsequent recall was superior to that found for encoding tasks that oriented participants' stimulus processing towards either the past or lacked a clear temporal focus. This outcome, we argued, was because memory is especially efficient in its performance when engaged by tasks designed to maximally utilise its evolved machinery (e.g., tasks that encourage the system to use information acquired in the past to plan and coordinate behaviour in the future).

PLANNING AND SURVIVAL

However, our future-oriented task asked participants to plan a camping trip in the forest. Thus, it could be argued that it was *survival* aspects of our future-oriented task, rather than future orientation, per se, that accounted for our recall findings. Such reasoning is favoured by Nairne and colleagues (e.g., Nairne, Pandeirada, Gregory, & Van Arsdall, 2009; Nairne & Pandeirada, 2008a, 2008b; Nairne, Padeirada, & Thompson, 2008; Nairne, Thompson, & Pandeirada, 2007), who have conducted a series of studies examining the memorial consequences of processing information for its relevance to the organism's survival. While these authors acknowledge that ''survival processing'' is likely not a unified domain (and therefore unlikely to be handled by a single cognitive mechanism; e.g., Nairne & Pandeirada, 2008b), they argue there is a strong a priori likelihood such processing will activate at least some specialised motivational machinery that interfaces with memory and give rise to superior recall and recognition. Consistent with this perspective, Nairne and colleagues consistently have demonstrated recall advantages for material judged for survival relevance when compared with material judged with respect to tasks that do not entail obvious relevance to survival.

However, survival processing, as operationalised in studies by Nairne and colleagues, may confound survival with planning (e.g., Klein et al., 2010). Decisions about an item's relevance to one's survival often entail a future-orientation and planning (e.g., what items would you take with you to survive if you were stranded on the savannah?). But it is not clear that it has to be this way. There appears to be no principled reason why reference to survival requires a causal connection to planning. For example, in certain situations a person can focus on his or her present circumstances when making survival-relevant decisions (e.g., deciding to take evasive action as a truck careens towards you out of control). And, of

course, planning need not logically entail considerations of survival. For example, it is perfectly possible to plan a psychological experiment without such plans having relevance to one's survival (at least, not in an evolutionarily meaningful sense of the word!).

In short, although planning and survival are correlated in many life experiences, their relation is contingent rather than one of logical necessity. Accordingly, it should be possible to examine independently the contributions of one (e.g., survival processing) to subsequent recall while controlling for the contributions of the other (e.g., planning processing). We do so in the present study by adopting (a) a planning task that is future-oriented but has little, if any, relevance for survival and (b) a survival task that focuses on the individual's survival but entails little, if any, planning.

Planning tasks: Previous failures to enhance recall relative to survival tasks

Many studies have compared survival encoding tasks with planning tasks and found the latter to yield inferior recall performance (e.g., Kang, McDermott, & Cohen, 2008; Nairne et al., 2007, 2008, 2009; Nairne & Pandeirada, 2008a, 2008b; Weinstein, Bugg, & Roediger, 2008; but for conflicting findings, see Butler, Kang, & Roediger, 2009; Klein et al., 2010). However, the planning and survival tasks in those studies differed along multiple dimensions including, but not limited to, context of encoding (e.g., survival in the wild versus planning an extended vacation or planning a move to a foreign country) and plausibility/familiarity of the planning scenario (planning a bank robbery, planning to go on a hunting trip, planning an extended stay in a luxury hotel, planning a move to a new home in a foreign land, evading an assassin in a strange city).

Moreover, participants in many planning studies were likely to have few, if any, personally relevant experiences regarding the planning being encouraged—e.g., moving to a foreign land, fighting attackers in the streets of a strange country, robbing a bank, taking a hunting trip on the savannah. Accordingly, these tasks often lacked a personal, real-world relevance that connected them in a meaningful way to participants' actual experience; what Klein, Loftus, and Kihlstrom (2002) labelled *lived time*. Lived time is personal, self-referential, and based primarily on episodic memory (see also Tulving, 2002). When it is future-oriented, lived temporality recruits self-referential episodic recollections, which are known to serve as the basis for imagined scenarios involving the self (e.g., Atance & O'Neill, 2005; Botzung, Denkova, & Manning, 2007; Boyer, 2007; Hassabis, Kumaran, Vann, & Maguire, 2007; Schacter, Addis, & Buckner, 2008; Suddendorf & Corballis, 1997, 2007; Szpunar, & McDermott, 2008; Szupnar, Watson, & McDermott, 2007; Wheeler, Stuss, & Tulving, 1997). Thus a connection with lived time may be important to the future-oriented function of memory for constructing personally relevant scenarios (for discussion, see Klein et al., 2010).

In short, planning tasks used in past research differed from the survival tasks in a number of ways—e.g., setting, plausibility, relevance to self—any of which (independently or in combination) might account for planning processing's inferior recall when compared with survival processing. Klein et al. (2010) attempted to control for these potential differences by requiring all encoding tasks (past, future, atemporal, and survival) to reference the same, personally familiar, and self-relevant scenario—a camping trip in the woods (all our participants had at least 1, and most considerably more, experience with the encoding context).

Under these circumstances, encoding that asked participants to plan what items to take on a camping trip (i.e., the future condition, which required planning but not survival processing; see Klein et al., 2010, for empirical validation of this assertion) gave rise to better recall of those items than did encoding that asked participants to remember what they had taken on a previous camping trip (i.e., the past condition) or encoding that requested participants form an image of a typical camping trip and report whether the to-be-recalled stimuli formed part of their image (i.e., the atemporal condition).

Our survival condition was modelled closely after that used by Nairne and colleagues (e.g., Nairne et al., 2007): participants were asked to imagine that they were stranded in the woods and to decide which of a list of items would be relevant to their survival. This condition produced recall superior to that found in both the past and atemporal conditions, but did not exceed that found in the planning condition.

One could, of course, argue that our future planning condition entailed survival concerns, thereby confounding the hypothesised effects of

future orientation with survival. If so, that would compromise our claim that the recall advantage found for planning encoding was due to future concerns. Pretesting, however, suggested this was not the case: Participants consistently rated the future-oriented planning task (i.e., the camping task) as highly unlikely to evoke thoughts of personal survival (on several pretest tasks, participants' mean ratings of survival-relevant thoughts varied between 1.50 and 1.75 on scales ranging in value from "1 = highly unlikely" to "5.00 = highly likely"). While this does not rule out an unconscious activation of survival concerns, there appears to be little conscious concern with survival when planning a camping trip.

One could also argue that locating the survival setting in the woods instead of in the savannah might inadvertently have lowered recall in that condition. Nairne and colleagues have argued that in the environment of evolutionary adaptation (the EEA; i.e., the conditions under which human memory would likely have evolved) our hominid ancestors roamed the grassy plains, not wooded forests (e.g., Nairne et al., 2007, 2009). This difference might have been sufficient to lessen the encoding effectiveness of the survival condition in our previous study.

Finally, a recent paper by Butler et al. (2009) addresses a potential problem with Nairne and colleagues' previous studies. Specifically, those studies had participants judge sets of unrelated stimulus words for their relevance to the various encoding scenarios used. Since items are known to be better recalled when they are congruent with processing goals (for review, see Wyer & Srull, 1989), it may be the case that Nairne's findings confounded processing goal and item congruence—i.e., the items presented were better recalled in survival conditions because they were more congruent with the demands required by that task. In support of this hypothesis, Butler et al. (2009) found that the survival recall advantage disappeared when item congruence was controlled across encoding tasks.

Taking these concerns into consideration, in the present study we compared two survival encoding conditions, both of which took place on the savannah. However, they differed in the extent to which they entailed future-oriented processing. In one condition participants judged which of a list of items (half of which were edible and half inedible) would be best to bring in anticipation of being stranded without food on the savannah. This condition combined both an obvious survival scenario (i.e., the need to eat) with a clear future orientation (i.e., planning what food items to take). This we termed our "Survival with Planning" condition.

A second condition also highlighted food-related survival concerns, but minimised the planning component of the task: Participants were told that they were stranded on the savannah and had come upon a cache of items, some of which were edible, some of which were not. Their job was to decide which of the items they could eat to survive. We predicted, and subsequent pretesting confirmed (see below), that under these circumstances, participants' concern with the need for planning would be greatly minimised. We label this the "Survival without Planning" condition.

A third condition emphasised future-orientated planning, but minimised survival concerns: Participants were asked to imagine they were going to shop for food items for a dinner party they were planning. Since this condition was neither survival relevant (see pretesting below) nor did it take place on the savannah (i.e., the EEA), it is a conservative test of the future-orientation hypothesis—i.e., that planning, rather than survival concerns, or location of the encoding context, mediates the good recall typically found for survival encoding. We label this task "Planning without Survival".

PRETESTING

In all three encoding conditions the same list of stimulus items were used. Half were obvious food items (e.g., apples, pasta, peanuts) and half were clearly inedible (e.g., paint, cyanide, glue), rendering them unfit for consumption, and thus of no benefit to personal survival in this situation. Since all three tasks required participants to focus on the nutritional aspects of presented stimuli, all items were pretested for relevance as food items. Specifically, 15 participants were asked to rate a list of 30 items on a 5-point scale ranging from "1 = Safe to Eat" to "5 = Unsafe to Eat". Half of the items on the list were preselected by the experimenters to be edible and half to be inedible. In accord with our intuitions, 15 items received a mean rating of 1.11 on the edibility

scale while the other half received a mean rating of 4.92, $t(28) = 52.79$, $p < .001$. The individual stimulus items, along with their mean ratings are presented in Appendix 1.

To address concerns about item/task congruence (Butler et al., 2009) it was necessary to show that our preselected stimulus items were equally relevant to the judgements requested by each of our three encoding scenarios. To do so, we selected a new set of participants ($N = 36$) and randomly divided them into three groups of 12. Participants were asked to rate the list of 30 items for relevance to their respective scenarios on a 5-point scale ranging from "1 = "Very Relevant" to "5 = Very Irrelevant". Instructions for the first group (Survival with Planning) read:

> Imagine that you are stranded on the savannah without any food. What food items would you plan to bring with you to survive in this situation? Below you will find a list of items. I would like you to rate the relevancy of each of these items as something you might plan to take with you to eat to increase your chances of survival. Some items may be very relevant. Others may be less relevant. It is up to you to decide.

The second group (Survival without Planning) received instructions similar to those of Survival with Planning, except the planning aspect of their decision was minimised:

> Imagine that you are stranded on the savannah without any food. However, you come across a collection of items, some of which are edible. Below you will find a list of those items. I would like you to rate the relevancy of each of these items as something you can eat to increase your chances of survival. Some items may be very relevant. Others may be less relevant. It is up to you to decide.

Finally, the third group (Planning without Survival) was told:

> Imagine that you are planning a dinner party for the weekend. You plan to go to the store to purchase some food. Below you will find a list of items. I would like you to rate the relevancy of each of these items to the food purchases you are planning. Some items may be very relevant. Others may be less relevant. It is up to you to decide.

A complete listing of item ratings for each of the three encoding contexts is presented in Appendix 2. Summarising those results, the "relevance" means for the 15 items previously judged to be edible were 1.57, 1.42, and 1.44 for Survival with Planning, Survival without Planning, and Planning without Survival, respectively (indicating high relevance). By contrast, the means for the 15 items previously judged inedible were 4.85, 4.79, and 4.85 across Survival with Planning, Survival without Planning, and Planning without Survival, respectively (indicating low relevance). As visual inspection of these means reveals, congruence of items across groups was controlled. Consistent with these observations, a two-way Analysis of Variance (ANOVA) on mean item relevance scores revealed only a single significant finding: Edible items were judged significantly more relevant to their respective scenarios than were non-edible items, $F(1, 42) = 2341.29$, $p < .0001$. The other main effect and interaction both fell far short of significance (both $ps > .70$). In short, our three encoding scenarios shared a virtually identical relation with regard to the relevance (or irrelevance) of the stimuli used in our study.

Prior to undertaking the main study we also felt it was important to empirically verify our intuitions concerning the amount of planning and survival processing engendered by each of our three encoding tasks. Specifically, we sought experimental confirmation that "planning a dinner party" does not evoke survival concerns in our undergraduate population (if it did, survival, rather than planning per se, might be responsible for the high level of recall predicted for planning processing). We also wanted to be certain that our survival manipulations (i.e., planning which food items to take on the savannah, and finding a cache of potentially edible items while stranded on the savannah) both entail survival concerns to approximately equal degrees, but that only the former task encouraged planning processing.

To evaluate these possibilities, we recruited an additional group of 36 undergraduates and randomly divided them into three groups of 12 participants. Each group was asked to complete a questionnaire containing 18 words representing both material objects (e.g., food, plants, pencils,

dirt) and more abstract concepts (e.g., fun, surprise, planning, survival). The complete list can be seen in Figure 1 or 2 in Klein et al. (2010). Participants in Survival with Planning were instructed:

> Take a few moments to imagine that you told you are going to be stranded on the savannah without any food. Pay attention to all of the feelings and thoughts that go through your mind as you imagine what food items you would plan to bring with you to survive this situation. To what extent does each of the following words describe what was going through your mind as you made your plans for your situation?

Instructions for Survival without Planning requested:

> Take a few moments to imagine that you are stranded on the savannah without any food. However, you come across a large collection of items, some of which are edible. Pay attention to all of the feelings and thoughts that go through your mind as you decide which of the items you can eat to increase your chances of survival. To what extent does each of the following words describe what was going through your mind as you decided which items you could eat to increase your chances for survival?

Instructions for Planning without Survival read:

> Take a few moments to imagine that you are going to be planning a dinner party for the weekend. You plan to go to the store to purchase food. Pay attention to all of the feelings and thoughts that go through your mind as you imagine what food items to buy. To what extent does each of the following words describe what was going through your mind as you made your plans for your party?

Each participant received a sheet of paper with instructions relevant to his or her group along with the 18 to-be-rated words (participants viewed one of two random orderings of the word list). They were asked to rate each word for the extent to which it captured thoughts or feelings going through their mind as they imagined their specific scenario. Scale values ranged from 1 = ''not at all'' to 5 = ''very much''. The relevant results pertain to group differences in the amount of survival and planning related thoughts evoked by instructions in their respective conditions. Accordingly, we conducted separate ANOVAs on the mean survival and planning ratings.

With respect to survival-related cognition, a one-way ANOVA yielded a significant main effect, $F(2,\ 51) = 242.52,\ p < .001$. Subsequent Tukey testing ($p < .05$) showed that the relative degree of survival-related thought encouraged by our encoding conditions varied in accord with expectations: The two survival groups (Survival with Planning and Survival without Planning) showed significantly more thoughts of personal survival than did Planning without Survival (planning a dinner party). The mean survival ratings for the three groups were: Ms = 4.56, 4.77, and 1.06 for Survival with Planning, Survival without Planning, and Planning without Survival, respectively.

Also, in line with our intuitions about differences across groups in thoughts about planning, a one-way ANOVA produced a significant main effect of planning, $F(2,\ 51) = 21.77,\ p < .001$. Tukey testing ($p < .05$) showed that Survival with Planning and Planning without Survival reported significantly more planning-related thoughts than did Survival without Planning (Ms = 4.22, 4.72, and 2.28, respectively).

In sum, while it always is possible to argue that ''survival'' and ''planning'' concerns play a nonconscious role in cognition about dinner parties and life on the savannah, participants' subjective reports revealed minimal conscious concern with survival in the Planning without Survival condition. By contrast, in Survival without Planning, participants rated the scenario high in evoking survival-related thoughts, but low in planning relevant cognitions. Finally, in a typical Nairne scenario (i.e., Survival with Planning), participants expressed a high level of awareness of both survival and planning implications of the proposed scenario.

Based on our pretest results, and arguments presented above, we predicted the recall performance associated with tasks encouraging planning (i.e., Survival with Planning and Planning without Survival) should exceed a task that encourages survival but not planning (i.e., Survival without Planning), despite the latter task's clear relevance to both survival and life in the EEA. With regard to the first two encoding conditions (the Survival with Planning and Planning without Survival

tasks), since both entail approximately equal amounts of planning (as per pretesting), we predicted approximately equal levels of recall. It is relevant to note that this prediction is a strong test of the future-orientation hypothesis since the ''planning a dinner party'' makes no reference to life on the savannah (i.e., the EEA).

STUDY 1

Method

Participants. A total of 162 undergraduates in an introductory psychology class participated in the study. The experiment was conducted in a single, mass-testing session lasting approximately 20 minutes.

Materials. Participants were randomly assigned to one of three encoding conditions ($N = 54$ per condition).

In the Survival with Planning scenario participants were told:

> Imagine that you are going to be stranded on the savannah without any food. What food items would you plan to bring with you to survive in this situation? Below you will find a list of items. I would like you to rate how likely each of these items is something you might plan to eat to increase your chances of survival. For some items, it may be very likely that you will select them. For others, it may be unlikely. It is up to you to decide.

Participants in the Survival without Planning condition were told:

> Imagine that you are stranded on the savannah without any food. However, you come across a collection of items, some of which are edible. Below you will find a list of those items. I would like you to rate how likely each of these items is something you can eat to increase your chances of survival. For some items, it may be very likely that you will select them. For others, it may be unlikely. It is up to you to decide.

Finally, in the Planning without Survival condition, participants received the instructions:

> Imagine you are planning a dinner party for the weekend. You plan to go to the store to purchase food. Since you are not sure of the guests' food preferences, you plan on purchasing a variety of different foods. Below you will find a list of items. I would like you to rate how likely it is that each of the items on the list is a food you might consider when planning for your party. For some items, it may be very likely that you will select them. For others, it may be unlikely. It is up to you to decide.

All participants viewed the same list of 30 stimulus words. The words all represented small, movable objects (e.g., sugar, carrots, glue, kerosene) that pretesting (see above) had shown were clearly relevant to participants' task decisions. The complete list can be found in the Appendix 1. Half the participants in each experimental condition were randomly assigned to receive one of two random orderings of the list words.

Design and procedure. At the start of the study, each participant received a four-page booklet containing the experimental material appropriate to his or her condition. Participants were instructed to remain on the page they currently were working on and not to turn from that page until requested to do so. They were also instructed not to refer back to a previous page in the booklet once work on that page had been completed. To ensure compliance, five research assistants monitored participant performance. There were no reports of any participants who failed to comply with these instructions

The first page of the booklet contained instructions describing the encoding task they would perform (see above). Underneath the task instructions were the 30 list words, printed one per line. Each word was accompanied by a 5-point scale that ranged from 1 = ''Very Relevant'' to 5 = ''Very Irrelevant''. Three minutes were allotted to complete this portion of the study (pretesting indicated that this interval was sufficient for participants to read instructions and make ratings at a comfortable pace).

Following the rating/encoding task, participants were instructed to turn to page 2, which asked them: ''Please use the scale below to indicate how hard you found the rating task. Circle the most appropriate scale value.'' The scale ranged from 1 = ''Very hard'' to 5 = ''Very Easy''; 30 seconds were provided to perform this rating. The next page contained a series of anagram completions and served as 3-minute distractor task. Participants were asked to

complete as many anagrams as they could in the time provided.

Participants then were asked to continue to page 4, which contained instructions for the recall portion of the study. The instructions read: ''We now would like you to try to recall the words you rated in the first part of the study. Please write the words, one per line, in the spaces provided below. You may recall the words in any order they come to mind.'' The page contained 30 blank lines. Five minutes were provided for recall, after which all the booklets were collected and participants debriefed.

Results

Mean recall as a function of encoding task is presented in Figure 1. Overall, participants successfully restricted their recall to the items presented: Out of the hundreds of items remembered, only five were extra-list intrusions (distributed across all three conditions, with only one participant producing more than a single intrusion). Intrusions were not counted as part of a participant's recall score.

A one-way ANOVA conducted on recall scores yielded a reliable effect of task, $F(2, 159) = 3.52$, $p < .05$, $MSE = 8.09$. Consistent with predictions, Tukey testing ($p < .05$) revealed that participants in the Survival with Planning condition and the Planning without Survival condition recalled significantly more words than did participants in the Survival without Planning condition. As can be seen in Figure 1 (and confirmed by Tukey testing, $p < .05$), Survival with Planning and Planning without Survival were virtually identical in the amount of recall they produced.

Since it is possible that participants found some of our rating tasks easier to perform than others, we also analysed participants' mean ''ease of rating'' scores. Although differences in ''ease of rating'' potentially could influence recall, it is hard to predict whether such an effect necessarily would be beneficial (e.g., Craik & Tulving, 1976). Fortunately, a one-way ANOVA on mean ''ease of rating'' scores found no significant differences between encoding conditions, $F(2, 159) = 2.67$, $MSE = .238$, *ns.* As shown in Figure 2, participants in all three conditions found their task very easy to perform, with mean ''ease of rating'' scores confined to a narrow range (4.72 and 4.89 on a 5-point scale).

Discussion

The results of this experiment provide further evidence that planning is a key variable in the superior recall performance found with survival processing tasks. In this study we systematically

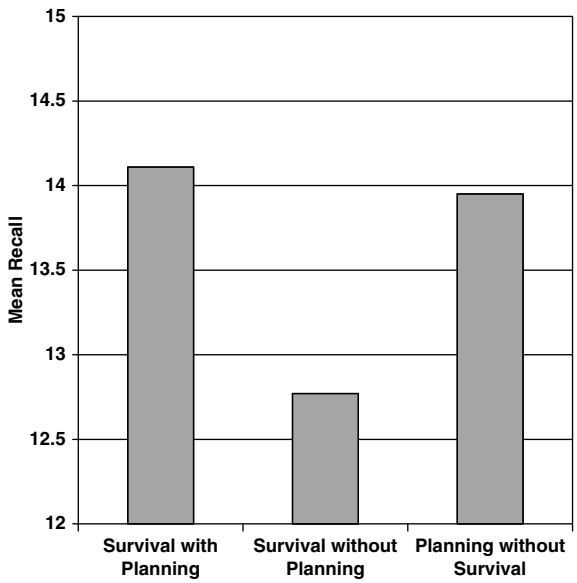

Figure 1. Mean recall of stimulus words (maximum possible = 30 words) as a function of encoding condition: Group 1 = Survival with Planning, Group 2 = Survival without Planning and Group 3 = Planning without Survival: Study 1.

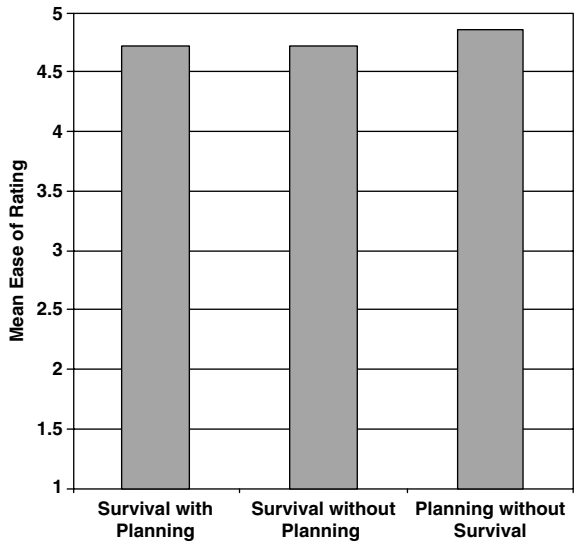

Figure 2. Mean ease of rating stimulus words as a function of encoding condition: Group 1 = Survival with Planning, Group 2 = Survival without Planning and Group 3 = Planning without Survival. Scale Values Ranged from 1 (*very hard*) to 5 (*very easy*): Study 1.

varied whether or not survival encoding included planning. We found that survival without a planning component was inferior to survival that also entailed planning.

Of course, it may be that *both* survival and planning are required for optimal task performance. However, in a third experimental condition participants made plans for a dinner party (i.e., the ''planning without survival'' condition). Under these circumstances participants' recall was virtually identical to that found for participants in the ''survival with planning'' task. This equivalence was obtained despite the ''planning without survival'' task (a) having virtually no survival relevance (see pretest results), and (b) having no reference to the assumed EEA: the savannah. In combination with our previous study (Klein et al., 2010) these findings suggest that the planning component of survival processing may be a key factor in the excellent recall that our future-orientation tasks yield.

This is not to say that survival processing does not have an important role to play in memory. There are numerous studies documenting its beneficial effects to recall and recognition (e.g., Klein, Cosmides et al., 2002; Nairne, 2005), and it is doubtful that any one factor (even planning) can explain all those results. It simply is our contention, that *one* part of the beneficial effects of survival processing to subsequent recall can be explained by the future orientation it engenders—i.e., the planning component. Although planning may be only one of several factors relevant to the excellent recall achieved with survival processing, it provides memorial potency not present when it is absent.

From a conceptual standpoint, survival may not be the optimal starting point for exploring the effects of natural selection on an organism. As we previously argued (Klein et al., 2010), it is not easy to enumerate a set of minimally necessary or sufficient behaviours that entail survival. Indeed, as developed in biological theory, the concept of survival encompasses everything that is not growth or reproduction—clearly an extremely heterogeneous set of activities and processes. So although natural selection can design distinct adaptations for distinct aspects of survival, it would be difficult for it to build a single adaptation for survival, per se (see also Nairne & Pandeirada, 2008b).

Planning is not a conceptual primitive either; rather, it consists in a set of evolved component processes, each of which has their own evolved function (for traditional treatments, see Miller, Galanter, & Pribram, 1960; Schank & Abelson, 1977; for a recent summary, see Lombardo, 2008). For example, Klein et al. (2010) argued that to plan for one's future one must, at a minimum, be able to (a) imagine possible futures, (b) set long-term personal goals, (c) construct hypothetical scenarios whose enactment will result in the realisation of an intended goal, and (d) evaluate the likelihood an imagined act will achieve the goal. However, when compared with survival, it is our contention that planning offers a more circumscribed set of behaviours on which natural selection can act.

Potential limitations. A question that immediately arises is why the savannah-related survival processing combined with a planning component should yield good recall in light of our earlier arguments (see Introduction) that planning for personal contingencies works optimally when it is based on personal recollections. After all, it is unlikely many of our participants have spent time on the savannah. Indeed, because of frequent requests for explication of the term ''savannah'' during previous studies, prior to the start of the current study we informed all participants that ''savannah'' could be likened to ''grasslands''. It is our contention that many of our participants (upon hearing that savannah is a grassland area) simply searched episodic memory for a personally relevant grassland-like context.

To explore this conjecture, on completion of the main study we randomly queried participants ($N = 57$) in both of the survival encoding conditions (i.e., with and without planning) about (a) how they conceptualised the ''savannah'' as they performed their respective tasks, and (b) whether that conceptualisation (if any) was based on personal experience. Since our verbal instructions to participants likened the savannah to grasslands (to enhance the clarity of a potentially unfamiliar term; as per Nairne et al., 2007), it was not surprising that the majority of responses pertained to images of fields and plains—both of which were also were highly likely to be based on personal experience (for participant responses, see Appendix 3). However, more work clearly needs to be done to obtain a better understanding of the episodic/planning connection in the savannah survival paradigm.

Another point that merits attention is the fact that although our Planning without Survival condition gave rise to recall almost identical to

that found in the Survival with Planning condition, this finding does not necessarily warrant the conclusion that they did so for the same reasons (i.e., by virtue of the planning component). They differ in a number of ways (e.g., context, goals) and there are many ways for different encoding tasks to produce comparable recall.

In partial response, we note that planning and survival were explicitly manipulated across our three experimental conditions, and planning was *the* variable that most clearly benefited recall. However, one still could maintain that differences in encoding context (e.g., savannah versus grocery store) played a role in recall not captured by our experimental manipulation of planning. To address this concern we offer evidence from Klein et al. (2010) in which context was kept constant across three (of our four) encoding tasks—past, atemporal, and future—while planning was intentionally varied: Under these circumstances the future oriented (i.e., planning) task yielded the best recall, and, once again, was comparable in performance to that found with a fourth task—a survival plus planning encoding condition.

Finally, one might argue that the Planning without Survival dinner planning task in the current studies required more effort in processing that did the other tasks. For example, perhaps participants found it more difficult to decide what to get for a party with others than what to select to eat for self-survival. However, both the ease of ratings scores and the task relevance scores of the individual stimuli render this concern somewhat less forceful.

In sum, each of these arguments, taken individually, does not resolve the main concern—scenario-based differences in the dinner planning and savannah survival tasks may play a role in obtained recall performance. But their collective force for the future-orientation/memory hypothesis is considerable.

STUDY 2

We now have demonstrated on two occasions (Klein et al., 2010, and the Study 1 of the present article) that, under certain conditions, planning absent survival concerns is as effective a mnemonic device as survival (with planning). The novel contribution of Study 1 was its demonstration that survival processing without planning led to inferior recall than did survival processing with planning. We sought to replicate this finding in Study 2.

Additionally, we changed scenarios slightly so that participants imagined being stranded in grasslands rather than a savannah. Given our experiences in Study 1, we felt this small change might mitigate potential confusion about the savannah encoding context.

Third, and more important, we altered the stimulus list to include *only* words with obvious benefits to food-based survival. In Study 1, as can be seen in Appendices 1 and 2, half the stimulus words were clearly edible and half were clearly inedible. Although our selection process was based on concerns voiced in Butler et al., (2009), the argument can be raised that such dramatic differences in stimulus goal relevance (e.g., no one is going to select kerosene as a food item) may have seriously minimised the extent to which participants engaged in meaningful processing of stimuli. As Nairne (personal communication, December 2009) has suggested, survival processing may be minimised when participants make selections from two sharp categories of words—highly relevant and highly irrelevant to processing goals. Such a clearly polarised set of items may be unlikely to induce substantial discriminative processing in any of our encoding conditions, but especially in the Survival without Planning condition (where anything edible is likely to be relevant).

Perhaps ''planning'' induces one to engage in more active discriminations among the items—e.g., would I *want* to eat that type of food?—than the simple survival decision in the Survival without Planning condition—e.g., *can* I eat that item? To address this concern, all stimulus items in Study 2 were clearly edible and the decision was left to each participant (rather than potentially mandated by context and list structure) as to whether she or he would find a particular food item one worth selecting.

The design, then, was a simple replication of the two survival conditions used in Study 1 (with and without the planning component) with a new list of words that we hoped would mitigate some of the potential problems discussed above. We did not include a planning without survival condition because (a) we already have demonstrated the relative equivalence in recall of conditions encouraging planning alone versus conditions encouraging planning plus survival in two separate studies (i.e., Study 1 and Klein et al., 2010), (b) after extensive pretesting we found it hard to

devise a scenario that required one to be stranded on the savannah/grasslands without also entailing a substantial element of survival-related cognition, and (c) Klein et al. (2010) already have demonstrated comparable recall for ''planning'' with and without ''survival'' in a common scenario, although the scenario entailed a camping context rather than a savannah-based context.

Pretesting

As in Study 1, before conducting the main part of the present study we felt it important to empirically document our intuitions about the amount of planning and survival processing engendered by our two encoding tasks. Specifically, we sought experimental confirmation that our survival manipulations (i.e., Survival with Planning and Survival without Planning) entailed approximately equal degrees survival-relevant concerns, but that only the former task encouraged planning processing as well.

A total of 25 undergraduates were recruited and randomly divided into two groups: 12 participants were placed in the Survival with Planning group and 13 in the Survival without Planning group. Each group was asked to complete the same questionnaire used in Study 1, which consisted in 18 words representing both material objects and more abstract concepts (e.g., survival and planning). As a reminder, the complete list can be found in either Figure 1 or 2 in Klein et al. (2010). Participants in the Survival with Planning group were instructed:

> Take a few moments to imagine that you told you are going to be stranded on the grasslands without any food. Pay attention to all of the feelings and thoughts that go through your mind as you imagine what food items you would plan to bring with you to survive this situation. To what extent does each of the following words describe what was going through your mind as you made your plans for your situation?

Instructions for Survival without Planning requested:

> Take a few moments to imagine that you are stranded on the grasslands without any food. However, you come across a collection of food items. Pay attention to all of the feelings and thoughts that go through your mind as you decide which of the items you would be likely to eat to increase your chances of survival. To what extent does each of the following words describe what was going through your mind as you decided which items you could eat to increase your chances for survival?

Each participant received a sheet of paper with instructions relevant to his or her group along with the 18 to-be-rated words (participants viewed one of two random orderings of the word list). They were instructed to rate each word for the extent to which it captured thoughts or feelings going through their mind as they imagined the scenario they were assigned to. Scale values ranged from 1 = ''not at all'' to 5 = ''very much''.

The relevant findings pertain to differences across groups in the amount of survival- and planning-related thoughts evoked by instructions in their respective conditions. Accordingly, we conducted separate tests on participants' mean survival and planning ratings. As anticipated, a *t*-test of participants' ratings of survival-related thoughts failed to yielded a significant effect, $t(23) = .74$, *ns*: Consistent with our intuitions (as well as the findings from Study 1), both groups produced a comparably large number of thoughts of personal survival while reading their respective scenarios (i.e., *M*s = 4.85 and 4.67, for Survival with Planning and Survival without Planning, respectively).

Also as expected, the two groups differed reliably in the extent to which their respective scenarios encouraged explicit thoughts of planning. An independent *t*-test yielded a reliable effect of planning, $t(23) = .5.75$, $p < .01$: Survival with Planning reported significantly more planning-related thoughts than did Survival without Planning: *M*s = 4.46 and 2.42 for the two groups, respectively).

We next conducted a more rigorous replication our exit interview findings from Study 1 concerning participants' thoughts and images of the ''savannah'': Specifically, 30 participants were given a single sheet of paper on which was written:

> Imagine that you are stranded on the grasslands without any food. How do you imagine grassland in your mind? In a word or short phrase please describe how you visualised or thought about the grasslands mentioned in the

first sentence. Was your image or thought of grasslands (if any) based on your personal experience?

The results can be found in Appendix 4. Paralleling our informal post-experimental findings from Study 1, most participants reported visualising grasslands (in Study 1 they were asked how they visualised "savannah") as either a field or a plain. Also, the majority of participants (20 out of 30) reported that their image was based on personal experience and recollections.

Finally, we wanted to evaluate our success in meeting concerns raised about the structure of the list of words used in Study 1. Given the heavily polarised nature of the stimulus set used in that study (items that either were obviously edible or obviously inedible) questions can be raised about the degree of discriminative, item-specific processing (e.g., Hunt & Einstein, 1981; Klein, Loftus, Kihlstrom, & Aseron, 1989) engendered by the different task scenarios in our first study. Since Nairne has suggested that the effects on memory of survival processing are most evident when the encoding task requires participants to actively discriminate among the items (personal communication), it remains possible that the stimulus set used in Study 1 resulted in less "picking and choosing" in the Survival without Planning condition: i.e., since only half of the presented items could potentially satisfy hunger, people in the Survival without Planning condition may have adopted a default mode in which they simply made an "edible or not" decision (after all, under the described circumstances—stranded in the wilderness—one can't afford to be too picky!).

By contrast, participants in the Survival with Planning condition have a greater opportunity for careful consideration when planning which (of the edible) items to take with them. Such differences in item-specific processing might explain the recall differences obtained between the survival tasks used in Study 1. To address this concern we created a new stimulus word list, this time consisting entirely of items that clearly were edible, though differed to a degree in their perceived utility to the two encoding scenarios.

To evaluate our success in achieving these goals we recruited an additional 32 participants and randomly divided them into two groups of 16. Participants were asked to rate a list of 30 food items for relevance to their respective scenario on a 5-point scale ranging from "1 = Very Relevant" to "5 = Very Irrelevant". Instructions for Survival with Planning read:

> Imagine that you are going to be stranded on the grasslands without any food. What food items would you plan to bring with you to survive in this situation? Below you will find a list of items. I would like you to rate how likely each of these items is something you might plan to eat to increase your chances of survival. For some items, it may be very likely that you will select them. For others, it may be unlikely. It is up to you to decide.

The Survival without Planning group received instructions similar to those of the Survival with Planning group, except the planning aspect of their decision was minimised:

> Imagine that you are stranded on the grasslands without any food. However, you come across a collection of food items. Below you will find a list of those items. I would like you to rate how likely each of these items is something you would be likely to eat to increase your chances of survival. For some items, it may be very likely that you will select them. For others, it may be unlikely. It is up to you to decide.

The complete listing of item ratings for each of the two encoding contexts is shown in Appendix 5. Summarising those results, the "relevance" means for Survival with Planning and Survival without Planning were 3.33 and 3.13 respectively. As visual inspection of these means reveals, relevance of items across groups appears controlled. Although some items were more relevant to one context than to the other (see below), they all, to varying degrees, were judged as edible.

Consistent with these observations, a *t*-test on the 30 mean item relevance scores for each group revealed no reliable differences, $t(58) = .82$, *ns*. Both groups also showed comparable variability (*SD*s = .83 and 1.06, for Survival with Planning and Survival without Planning, respectively) and comparable spread in item ratings (range = 1.63–4.56 for Survival with Planning; 1.25–4.81 for Survival without Planning).

As can be seen in Appendix 5, participants' decisions, though similar across encoding conditions, were not identical: Participants who had to decide which food items to eat from items discovered on the grasslands made different judgements with respect to certain items than

did participants who were requested to plan which items to take with them in anticipation of their ordeal. For example, while Survival without Planning participants were very likely to eat the grapes they found ($M = 1.50$), Survival with Planning participants were less likely to view grapes as a part of their planned menu ($M = 3.13$). Conversely, Survival with Planning participants were quite likely to include salt in their meal planning ($M = 2.44$), whereas Survival without Planning participants did not consider this condiment something to eat when found ($M = 4.13$).

Finally, in accord with the findings of Butler et al. (2009), our stimulus items—all clearly edible—had direct relevance to the tasks in which they were to be used. In short, the various analyses and arguments presented above suggest that the stimulus items used in Study 2 largely met the concerns that guided their initial selection.

Method

Participants. A total of 54 undergraduates in an introductory psychology class participated in the study. The experiment was conducted in a single, mass-testing session lasting approximately 20 minutes.

Materials. Participants were randomly assigned to one of two encoding conditions ($N = 27$ per condition).

In the Survival with Planning condition participants were told:

> Imagine that you are going to be stranded on the grasslands without any food. What food items would you plan to bring with you to survive in this situation? Below you will find a list of items. I would like you to rate how likely each of these items is something you might plan to eat to increase your chances of survival. For some items, it may be very likely that you will select them. For others, it may be unlikely. It is up to you to decide.

Participants in the Survival without Planning condition were told:

> Imagine that you are stranded on the grasslands without any food. However, you come across a collection of food items. Below you will find a list of those items. I would like you to rate how likely each of these items is something you would be likely to eat to increase your chances of survival. For some items, it may be very likely that you will select them. For others, it may be unlikely. It is up to you to decide.

All participants viewed the same list of 30 stimulus words (see Appendix 4). The words all represented edible items that pretesting had shown were clearly relevant to participants' task decisions. Half the participants in each experimental condition were randomly assigned to receive one of two random orderings of the list words.

Design and procedure. The design and procedure were identical to that of Study 1 with the following changes. First, the stimulus items consisted of 30 words that all represented food items that pretesting had shown were equally relevant to processing in both encoding scenarios. Second, we changed the term "savannah" to the term "grasslands" since (a) participants in our previous studies found the latter term more comprehensible and (b) Nairne and colleagues (e.g., Nairne et al., 2007, 2009) have shown that grasslands and savannah are terms that function equivalently in the survival encoding context. Finally, we eliminated the Planning without Survival condition because we were unable to construct a scenario that involved being stranded alone on the grasslands while adequately minimising survival-relevant cognitions (for a successful elimination of survival thoughts in a planning task, albeit in a woodlands setting, see Klein et al., 2010).

Results

Mean recall as a function of encoding task is presented in Figure 3. As predicted, an independent *t*-test on the mean recall data revealed that participants in Survival with Planning recalled significantly more words ($M = 17.11$; $SD = 2.86$) than did participants in Survival without Planning ($M = 15.67$; $SD = 3.34$), $t(52) = 1.71$, $p < .05$, one-tailed (e.g., Bruning & Kintz, 1987; Rosenthal & Rosnow, 1985).

It remains possible that participants in one condition found their rating tasks easier to perform participants in the other condition, although pretest findings lessen this possibility

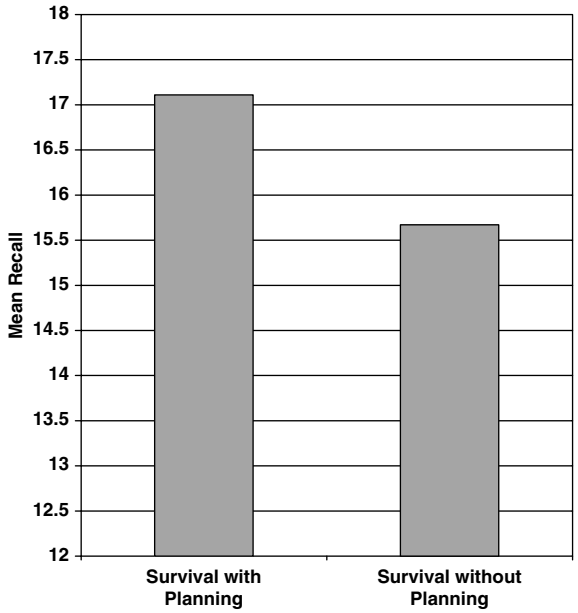

Figure 3. Mean recall of stimulus words (maximum possible = 30 words) as a function of encoding condition: Group 1 = Survival with Planning, Group 2 = Survival without Planning: Study 2.

considerably If this were true, it might account for recall differences across tasks. Accordingly, we analysed participants' mean "ease of rating" scores, $t(52) = .41$, ns: As shown in Figure 4, the mean "ease of rating" scores were virtually identical across groups (4.33 and 4.26 on a 5-point scale, for Survival with Planning and Survival without Planning, respectively).

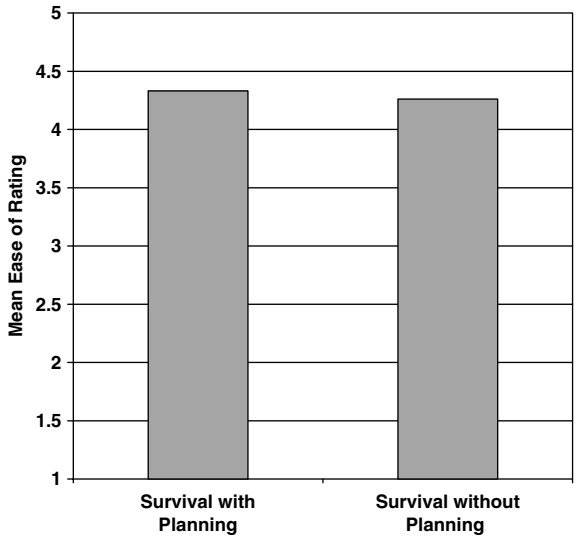

Figure 4. Mean ease of rating stimulus words as a function of encoding condition: Group 1 = Survival with Planning, Group 2 = Survival without Planning. Scale Values Ranged from 1 (*very hard*) to 5 (*very easy*): Study 1.

DISCUSSION

In Study 2 we replicated the effects of survival with and without a planning component on recall using a stimulus set more likely to equate discriminative, survival-relevant processing across conditions. Although the magnitude of the recall effect in the present study was comparable to that of our first study, levels of significance varied. In Study 1 a non-directional analysis yielded a statistically reliable effect of recall following "survival with planning" when compared to the "survival without planning" group. In our second study, using different stimulus material, the same pattern of recall differences emerged, but the difference was significant only at the one-tailed testing level. However, since the obtained effect was predicted (both theoretically and empirically; i.e., the results of Study 1), the adoption of single-tail testing was justified (e.g., Rosenthal & Rosnow, 1985).

Reasons for statistical variability across studies may have to do with (a) use of different stimulus word sets in Study 1 and 2 (as discussed above) and (b) the manipulation effectiveness. Simply put, it is hard to remove all planning considerations from "grassland-based" survival scenarios. Even though pretesting showed we were successful in both studies in creating scenarios that statistically minimised planning in a survival context, the planning scores still were greater than 2.00 on a 5-point scale. This suggests some variability among participants in the degree to which planning to some extent played a part in the "survival without planning" condition.

Despite these concerns, both in terms of absolute number of items recalled (see Figures 1 and 3) and statistical testing, we were successful in demonstrating that survival on the savannah (a) is a powerful encoding task (e.g., Kang et al., 2008; Klein et al., 2010; Nairne et al., 2007, 2009: Nairne & Pandeirada, 2008a), (b) that under the conditions typically employed by Nairne and colleagues (i.e., savannah-based encoding scenarios) it is possible to empirically separate the contingent (though not logically necessary) relation between survival and planning, and, most important, (c) when planning and survival are separated, planning is found to make a contribution to recall over

and above that found for survival processing alone. In short, as both Klein et al. (2010) and the present studies show, planning constitutes a significant causal component of the excellent recall produced under ''survival on the savannah'' encoding conditions.

This is not to say that planning is solely responsible for the excellent recall produced in survival studies (although Klein et al., 2010, and Study 1 of the present paper can be interpreted in that light). As noted earlier, there have been a number of previous failures to find comparably high levels of recall associated with ''planning without survival'' manipulations (although, to the best of our knowledge, none of those studies has empirically documented the presence or absence of planning- and survival-relevant cognition in their tasks). In both the present study, and in our earlier paper, we addressed this empirical disparity, providing experimental support for our intuitions about the amount of survival and planning encouraged at encoding, and offered several theoretical reasons for the divergent findings reported (see also the Introduction to the present paper). We believe that the evidence we have presented strongly suggests that survival processing without a planning component is reduced in its effectiveness as a recall task. Of equal importance, under the proper circumstances, planning, when separated from thoughts of survival, can have a robust effect on recall performance.

CONCLUSIONS

Over the course of evolution, modifications in the design of human memory were incorporated to the extent that they increased the ability of neurocognitive machinery to successfully solve adaptive information-processing problems (e.g., Cosmides & Tooby, 1987; Klein, Cosmides et al., 2002; Sherry & Schacter, 1987). Planning and an orientation towards the future, two clearly interrelated skills, greatly enhance their owner's chances for survival (e.g., Klein et al., 2010; Lombardo, 2008; Suddendorf & Corballis, 1997). Accordingly, planning for future contingencies is, in our view, a specific, evolved set of mechanisms designed to help solve a general problem—how to remain alive long enough to reproduce and care for one's offspring.

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APPENDIX 1

Mean "safe to eat" ratings for our 30 stimulus items

Words rated "safe to eat"	Mean rating	Words rated"unsafe to eat"	Mean rating
Bread	1.00	Cyanide	4.93
Flour	1.33	Kerosene	5.00
Butter	1.27	Motor Oil	5.00
Peanuts	1.00	Antifreeze	5.00
Potatoes	1.07	Oven Cleaner	5.00
Carrots	1.00	Arsenic	5.00
Soup	1.00	Paint	5.00
Tomato Sauce	1.00	Gasoline	5.00
Pasta	1.00	Drano	5.00
Salt	1.40	Glue	4.13
Sugar	1.47	Turpentine	5.00
Chocolate	1.00	Asbestos	4.93
Cheese	1.07	Peroxide	4.87
Corn	1.00	Mercury	4.87
Apples	1.00	Insecticide	5.00
Means for List	1.11		4.92

Scale ratings ranged from 1 = "safe to eat" to 5 = "unsafe to eat": Study 1.

APPENDIX 2

Mean "scenario relevance" ratings for our 30 stimulus items

Scenario 1 – Savannah and Planning

Words rated "Very relevant"	Mean rating	Words rated "Very irrelevant"	Mean rating
Bread	1.08	Cyanide	4.83
Flour	2.33	Kerosene	4.50
Butter	2.33	Motor Oil	4.92
Peanuts	1.33	Antifreeze	5.00
Potatoes	1.33	Oven Cleaner	4.92
Carrots	1.25	Arsenic	4.92
Soup	1.17	Paint	4.75
Tomato Sauce	1.83	Gasoline	4.67
Pasta	1.25	Drano	5.00
Salt	1.92	Glue	4.75
Sugar	2.17	Turpentine	5.00
Chocolate	1.58	Asbestos	4.92
Cheese	1.42	Peroxide	5.00
Corn	1.33	Mercury	5.00
Apples	1.17	Insecticide	4.58
Means for List	1.57		4.85

Scenario 2 – Savannah without Planning

Words rated "Very relevant"	Mean rating	Words rated "Very irrelevant"	Mean rating
Bread	1.00	Cyanide	4.83
Flour	2.00	Kerosene	4.42
Butter	1.33	Motor Oil	4.50
Peanuts	1.25	Antifreeze	4.75
Potatoes	1.08	Oven Cleaner	5.00
Carrots	1.45	Arsenic	4.92
Soup	1.17	Paint	4.92
Tomato Sauce	1.50	Gasoline	4.25
Pasta	1.25	Drano	4.92
Salt	2.00	Glue	4.67
Sugar	1.92	Turpentine	4.83
Chocolate	1.67	Asbestos	4.83
Cheese	1.08	Peroxide	4.50
Corn	1.08	Mercury	5.00
Apples	1.00	Insecticide	4.75
Means for List	1.42		4.74

Scenario 3 – Dinner Party Planning

Words rated "Very relevant"	Mean rating	Words rated "Very irrelevant"	Mean rating
Bread	1.25	Cyanide	5.00
Flour	2.17	Kerosene	4.92
Butter	1.25	Motor Oil	5.00
Peanuts	1.92	Antifreeze	4.92
Potatoes	1.33	Oven Cleaner	4.17
Carrots	1.67	Arsenic	4.92
Soup	1.58	Paint	5.00
Tomato Sauce	1.42	Gasoline	4.50
Pasta	1.17	Drano	4.75
Salt	1.25	Glue	4.83
Sugar	1.42	Turpentine	4.83
Chocolate	1.42	Asbestos	5.00
Cheese	1.08	Peroxide	5.00
Corn	1.25	Mercury	5.00
Apples	1.42	Insecticide	4.92
Means for List	1.44		4.85

Scale ratings ranged from 1 = "Very relevant" to "5 = Very irrelevant": Study 1.

APPENDIX 3

Free responses to the question "How (if at all) did you imagine the savannah as you performed the initial rating task?" ($N = 57$): Study 1

Response	Number of participants	Based on personal experience?
Field	24	21
Plains	12	9
Orchard	4	2
Woods	4	4
Prairie	3	2
Grove	3	1
Meadow	2	2
Other (e.g., "don't know" "did not visualise"; African plains")	5	NA

APPENDIX 4

Free responses to the question "How did you imagine the grasslands described in the questionnaire?" ($N = 30$): Study 2

Response	Number of participants	Based on personal experience?
Field	12	8
Plains	8	6
Prairie	3	3
African Plains	3	0
Marshlands	1	0
Island	1	1
Flatlands	1	1
Hilly Terrain	1	1

APPENDIX 5

Mean likelihood of item selection as a function of scenario: Study 2

Scenario		
	Survival with Planning	Survival without Planning
Stimuli	Mean rating	Mean rating
Bread	1.63	1.25
Flour	2.82	4.19
Jalapenos	4.50	4.25
Peanut Butter	2.38	2.56
Ice Cream	4.00	3.25
Coffee	3.75	3.63
Grapes	3.13	1.50
Salsa	3.88	3.62
Candy	3.25	3.38
Lard	4.25	4.13
Spam	3.56	3.38
Pie	3.81	2.81
Broccoli	2.69	1.94
Steak	3.13	2.38
Relish	4.56	4.50
Carrots	3.00	1.94
Mustard	4.25	4.63
Tomato Sauce	4.19	3.81
Pasta	2.81	2.19
Salt	2.44	4.13
Vegetable Oil	3.69	4.25
Rice	1.88	1.94
Cheese	2.50	2.19
Yogurt	3.43	2.38
Apples	1.75	1.50
Tabasco Sauce	4.06	4.63
Baking Soda	4.56	4.81
Potato Chips	3.06	3.25
Chocolate	3.43	2.44
Pickles	3.62	3.13
Mean scenario rating	3.33	3.13
Standard deviation	.83	1.06

Scale ratings ranged from 1 = "Very likely" to "5 = Very unlikely".