The effect of survival processing on memory for pictures depends on how memory is tested

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Abstract

Two experiments investigated the effects of survival processing on memory for pictures of objects. In experiment 1, participants were presented with 32 pictures of common objects and rated them for their relevance to a survival scenario, a moving home scenario, or for pleasantness. In a surprise recall test, participants in the survival condition recalled more of the verbal labels of the objects than participants in the moving and pleasantness conditions. In experiment 2, participants rated 64 pictures of objects in survival, moving home, or pleasantness conditions. Memory for visual detail was assessed using a forced-choice recognition test in which participants had to decide which of two highly similar pictures was the one they rated at study. In contrast to the results of experiment 1, correct recognition scores were highest in the pleasantness condition and lowest in the survival condition. This pattern suggests that survival processing enhances memory for objects but not for precise visual detail. The findings are consistent with the view that rating objects for their survival value directs attention to the potential uses of the objects. They also emphasise the importance of the match between encoding and retrieval processes in the survival processing paradigm.

Keywords: Survival processing; picture memory; transfer-appropriate processing

Survival processing enhances memory for objects but not for visual detail

In the survival processing paradigm, first reported by Nairne and colleagues (e.g., Nairne, Thompson, & Pandeirada, 2007; Nairne, Pandeirada, & Thompson, 2008; Nairne & Pandeirada, 2010), participants who rate information for its relevance to a survival scenario remember more of that information, relative to participants who process the information in other ways. In the first demonstration of this effect, Nairne et al. (2007) asked participants to imagine that they were stranded in the grasslands of a foreign country and would have to find food and water and avoid predators in order to survive. Participants were then asked to rate a series of object nouns for their relevance to this scenario. In a surprise recall test, participants recalled more of the object nouns than participants who rated them for pleasantness, self-reference, or relevance to a 'moving home' scenario in which they imagined they were moving to a foreign country. This effect has been observed in both recall and recognition memory (Nairne et al., 2007) and when control conditions are matched for emotional arousal (Kang et al., 2008) and distinctiveness (Röer et al., 2013).

In a review of the survival processing paradigm, Nairne and Pandierada (2016) referred to a distinction posited by evolutionary theorists between *ultimate* and *proximate* explanations. Ultimate explanations refer to how a particular trait evolved, whereas proximate explanations focus on the underlying mechanisms. Nairne et al. (2007) proposed an ultimate explanation of the survival processing effect whereby memory systems are 'tuned' to remember information that is relevant to survival. A number of studies have tested this view by comparing the grasslands survival scenario with modern-day survival scenarios, such as being lost in an unfamiliar city. Some studies have shown that the grasslands scenario leads to a greater memory enhancement than modern-day scenarios (Nairne & Pandeirada, 2010, Weinstein et al., 2008). In contrast, other studies have found that the grasslands scenario is no more effective than a scenario in which participants imagine themselves lost at sea or even lost in a spaceship (Kostic et al., 2012) or being chased by zombies (Soderstrom & McCabe, 2011). Although these scenarios are not ancestrally-relevant, Nairne and Pandeirada (2016) argued that they activate more general survival mechanisms that respond to all forms of threat.

Proximate explanations of the survival processing effect have drawn on basic memory phenomena (see Erdfelder & Kroneisen, 2014, for a review.) Examples include arousal (e.g., Kang et al., 2008), congruity (e.g., Butler et al., 2009), and the combined influence of item-specific and relational processing (Burns et al., 2011). In their review, Erdfelder and Kroneisen concluded that the findings to date can be explained in terms of enhanced richness-of-encoding. According to this account, survival processing gives rise to elaborate and distinctive encoding which supports multiple routes to retrieval. This is supported by the findings of Kroneisen and Erdfelder (2011) who found that the survival processing advantage was eliminated when encoding conditions restricted the degree of elaboration, for example by reducing the survival rating scenario to the single problem of finding potable water.

Direct evidence for a richness-of-encoding account was provided by Röer et al. (2013). They presented participants with a series of object nouns and asked them to list the possible uses to which each object could be put in either a survival scenario, a moving home scenario, or an ‘afterlife’ scenario in which they had to think of ways to prevent boredom in an eternal afterlife. Röer et al. found that participants generated more possible uses for objects in the survival condition relative to the other two conditions. Thinking about the potential uses of objects was also shown to be important in a study by Bell et al. (2014). They found that instructions that direct attention to the functions of objects led to higher recall levels than instructions that focused on threat.

As noted above, the elaborative encoding produced by survival processing supports multiple routes to retrieval. This is evidenced by the findings of McBride et al. (2013) who found that survival processing does not enhance memory in a cued recall test. As noted by Nairne and Pandeirada (2016), restricting retrieval to a specific cue undermines the advantage of having multiple retrieval routes. In a recent study, Alban and Annibal (2022) directly investigated the role of retrieval cues in the survival processing paradigm using a transfer-appropriate processing approach, which emphasises the importance of the match between encoding and retrieval processes (Morris et al., 1977). Alban and Annibal (Experiments 1a and 1b) compared the survival processing task with a task in which participants generated associates of the study words. Participants were then given either a standard recognition test or an associates task in which they indicated whether a test item was a word that people would be likely to produce in the generation task presented at study. They found that reducing the overlap between study and test conditions (survival processing followed by the associates task, or generation followed by a recognition test) reduced performance for both the survival and generation conditions, but that the reduction was greater for the survival condition. These findings, together with those of Kroneisen and Erdfelder (2011), highlight the importance of retrieval processes in the survival processing effect.

Whilst a survival processing advantage has been widely demonstrated in the retention of object nouns, attempts to extend the effect to other materials have produced mixed results. Survival processing does not enhance the recall of abstract words (Bell et al., 2013) or words of low imageability (Kroneisen & Makerud, 2017). Kroneisen and Makerud suggested that the effect is limited to high-imageability words because it is easier to imagine practical uses of items that can be visualised. Nairne et al. (2007) found that survival processing led to higher recall levels than an autobiographical self-reference task in which participants rated words for how easily they bring to mind a personal experience. However, Dewhurst et al. (2017) found that survival processing was less effective than a descriptive self-reference task in which participants rated trait adjectives for either self-reference or survival value (see

Klein et al., 1989, for discussion of the differences between autobiographical and descriptive self-reference tasks). Moving beyond memory for individual words, Seamon et al. (2012) found that survival processing did not enhance memory for the factual content of stories, and Savine et al. (2011) found no advantage for survival processing in face recognition.

In contrast, some studies have shown that the survival processing effect can enhance other aspects of memory besides the recall of object nouns. For example, Nairne et al. (2012) found that survival processing enhanced the recall of object locations. Participants were shown pictures of food items either close to or more distant from the centre of the screen. Participants had to rate how easy it would be to collect the items in either a survival scenario or a scavenger hunt scenario. In a surprise recognition test, the same pictures were shown again and participants were instructed to move the mouse to indicate where the item had previously appeared on the screen. Location memory was more accurate in the survival condition relative to the scavenger hunt condition. In a second experiment, food items were replaced with pictures of animals and participants were asked to rate how easy it would be to capture them. As in their first experiment, location memory was more accurate in the survival condition.

Of particular relevance to the current study is the finding by Otgaar et al. (2010) that survival processing enhanced the recall of pictures as well as object nouns. Participants were presented with pictures from the International Affective Picture System (IAPS; Lang et al., 1995) and rated them for their relevance to a survival scenario, a moving home scenario, or for pleasantness. Following a brief distractor task, participants were asked to recall the verbal labels of the pictures presented in the rating task. Otgaar et al. found that participants in the survival condition recalled significantly more verbal labels than participants in the moving home and pleasantness conditions, thereby extending the survival processing effect to picture stimuli. This pattern was maintained when study ratings were entered as a covariate, indicating that the survival advantage was not simply an artefact of the higher study ratings in the survival condition.

Building on the work of Nairne et al. (2012) and Otgaar et al. (2010), the question we addressed in the current study was whether survival processing enhances memory for the visual detail of pictures. In terms of the evolutionary argument proposed by Nairne et al. (2007), a case could be made that the ability to remember precise visual detail would confer a survival advantage; for example, in recognising predators or distinguishing between edible and poisonous berries. Despite this, there has been little research into the effect of survival processing on memory for visual detail. As noted above, Savine et al. (2011) investigated the effects of survival processing on memory for visual stimuli in the form of faces and found no advantage, but face recognition has been shown to rely on holistic processes, in which a face is recognised as a configuration rather than a collection of individual features (Farah et al., 1998). Otgaar et al. (2010) found that survival processing enhanced memory for pictures, but the free recall tests they employed measured recall of the concepts rather than visual details of the pictures. However, Otgaar et al. also measured memory for visual details by asking participants to provide descriptions of the pictures they recalled. Interestingly, they found that participants in the pleasantness condition correctly recalled more details than participants in the survival and moving conditions, but the difference was not statistically significant.

In order to measure the effects of survival processing on memory for visual detail, we presented participants with a series of pictures followed by a forced-choice recognition test in which they had to decide which of two highly similar pictures was presented at study. It is important to note, however, that the pictures we used differed in important ways from those used by Otgaar et al. (2010). Otgaar et al. used pictures from the IAPS (Lang et al., 1995) which varied systematically in arousal and valence. Many of the pictures in the IAPS database also depict complex scenes. In contrast, the pictures used in the current study were of simple, emotionally neutral objects on a plain white background. Because of these differences, we felt that an important first step was to replicate the procedure used by Otgaar et al. and present the pictures in survival, moving, or pleasantness rating conditions followed by a free recall test in which participants had to recall the verbal labels of the pictures they rated. This is presented as experiment 1. We then present experiment 2 in which we employed a forced-choice recognition test specifically designed to measure memory for visual detail.

Experiment 1

Method

Participants. Participants were 90 undergraduate and postgraduate students, of whom 56 identified as female and 34 as male, in the age range 18-54 (M = 25.07, SD = 8.17). All were fluent English speakers. Participants were tested at individual workstations in groups of up to 4 and received either course credit or a gift voucher for their participation. There were 30 participants in each of the three conditions. Sample sizes were based on the rule of thumb proposed by Wilson van Voorhis and Morgan (2007) of 30 participants per cell. This was well above the total sample size of 63 suggested using G*Power (Faul et al., 2007) for an omnibus, one-way ANOVA on the main effect of rating task on memory, with an effect size of f = .52 (estimated from Otgaar et al., 2010, experiment 1). Both experiments reported in this paper were approved by the Ethics Committee of the Faculty of Health Sciences at the University of Hull.

Stimuli and design. The stimuli were created with both experiments 1 and 2 in mind and consisted of 64 pairs of pictures of common objects (e.g., kitchen utensils, food and drink, electrical items). The original stimuli were selected from the set of categorised objects developed by Konkle et al (2010) in which each picture shows an individual object on a white background. Two examples of each object were chosen, based on visual similarity as judged by the researchers, to be used as target and lure items in a forced-choice recognition test (reported as experiment 2). As picture recognition is particularly accurate (Shepard, 1967; Standing, 1973) these pairs were piloted on ten participants using a survival processing study phase followed by a forced-choice recognition task. The mean correct recognition score of 96% indicated a possible ceiling effect. We therefore conducted an internet search for images from the same categories as those developed by Konkle et al. that more closely resembled one member of each pair. A second pilot study (n = 10) using the new pairs produced a mean recognition score of 80%, indicating that the task was sufficiently discriminating. Stimuli are available from the first author on request.

For experiment 1, 32 of the 64 pairs of pictures were randomly selected for use in a free recall study. One picture from each pair was randomly chosen and presented to all participants. Verbal labels were not included. Participants rated each picture in one of three rating conditions (survival, moving home, and pleasantness) manipulated in a between-groups design. The pictures were presented in a different random order for each participant.

Procedure. Participants were informed that the aim of the study was to rate a set of pictures. They were told that there were no right or wrong answers and that the researchers were simply interested in their judgements. An incidental learning procedure was used whereby participants were not informed in advance that their memory for the pictures would be tested. Prior to the presentation of the pictures, participants received one of the following sets of instructions, adapted from Nairne et al. (2007):

Survival condition. *In this task, I would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. I'm going to show you a series of pictures of common objects, and I would like you to rate how relevant each of these objects would be for you in this survival situation. Some of* *the objects may be relevant and others may not—it's up to you to decide. Please use the keyboard to rate the objects from 1 (totally irrelevant) to 5 (extremely relevant).*

Moving condition*. In this task, I would like you to imagine that you are planning to move to a new home in a foreign land. Over the next few months, you'll need to locate and purchase a new home and transport your belongings. I'm going to show you a series of pictures of common objects, and I would like you to rate how relevant each of these objects would be for you in accomplishing this task. Some of the objects may be relevant and others may not—it's up to you to decide. Please use the keyboard to rate the objects from 1 (totally irrelevant) to 5 (extremely relevant).*

Pleasantness condition*. In this task, I'm going to show you a series of pictures of common objects, and I would like you to rate the pleasantness of each picture. Some of the pictures may be pleasant and others may not—it's up to you to decide. Please use the keyboard to rate the objects from 1 (unpleasant) to 5 (pleasant).*

The pictures appeared one at a time and participants rated them on a 5-point Likert scale presented underneath each picture. The pictures remained on the screen for 5 seconds regardless of how quickly participants responded. After completing the rating task, participants performed a letter cancellation filler task for 2 minutes. They were then given a surprise free recall test in which they had 5 minutes to write the names of all the objects they could recall.

Results and discussion

A picture was classed as correctly recalled if participants reported the correct verbal label. Synonyms or close approximations (e.g., *balloon* instead of *hot air balloon*) were also classed as correct. In the very few cases of ambiguity, judgements were made by the first author and confirmed by the second author. Alpha was set at .05 for all main effects and interactions, and all pairwise comparisons were Bonferroni-adjusted. Table 1 shows mean study ratings and mean proportions of correct recall for the three rating conditions. Study ratings were entered into a one-way between-groups ANOVA with rating task (survival x moving x pleasantness) as the independent variable. A significant main effect of rating task was observed, F (2,87) = 20.80, MSE =.28, $p < .001$, $\eta_p^2 = .33$. Pairwise comparisons showed that pleasantness ratings were significantly higher than ratings for survival, $p = .043$ and moving, $p < .001$. Ratings for survival were also significantly higher than ratings for moving, $p = .001$.

Numbers of correct recall were also entered into a one-way ANOVA with rating condition survival x moving x pleasantness) as the between-groups independent variable. This produced a significant main effect, F (2,87) = 12.01, MSE = 10.03, $p < .001$, $\eta_p^2 = .22$. Pairwise comparisons showed that survival rating produced significantly higher correct recall scores than both moving home, $p = .005$, and pleasantness, $p < .001$. There was no significant difference between the moving and pleasantness conditions, $p = .34$. In order to determine whether recall scores were influenced by study ratings, an ANCOVA for recall scores with study rating as the covariate was conducted. This also showed a significant main effect of rating task, F (2,86) = 12.25, MSE = 10.08, $p < .001$, $\eta_p^2 = .22$. Pairwise comparisons showed that survival rating again led to significantly higher recall scores than moving, $p = .027$, and pleasantness, $p < .001$. Moving and pleasantness did not differ significantly from each other, $p = .26$.

The findings of Experiment 1 are consistent with those of Otgaar et al. (2010) and provide further evidence that the survival processing advantage extends to pictures. As discussed above, the pictures we used differed from those use by Otgaar et al. in that they depicted single objects on a white background, as opposed to the complex scenes used by Otgaar et al. Despite this, we replicated the findings that survival processing leads to both higher study ratings and higher recall scores than survival processing. The only departure from the pattern reported by Otgaar et al. is that ratings were higher in the pleasantness condition than in the survival condition. This is likely to reflect differences in the stimuli, as the pictures used by Otgaar et al. included some of negative valence which were likely to be rated as unpleasant.

Whilst we considered it important to show that the pictures we used produced the same patterns of free recall as those used by Otgaar et al. (2010), our main focus was on whether survival processing enhances memory for visual detail. To that end, we conducted experiment 2 in which memory was measured by a forced-choice recognition test in which participants had to decide which of two visually similar pictures was presented at study.

Experiment 2

Method

Participants. A new group of 90 undergraduate students, of whom 63 identified as female and 27 as male, in the age range 18-42 (M = 22.64, SD = 6.05) participated for course credit. All were fluent English speakers. There were 30 participants in each of the three rating conditions. They were tested at individual workstations in groups of up to 4.

Stimuli, design, and procedure. The full set of 64 pairs of pictures described for experiment 1 were used in experiment 2. One picture of each pair was randomly selected for the rating task. Choice of picture and the presentation order were determined randomly for each participant. After completing the rating task, participants were engaged in a nonverbal filler task (maths problems) for 10 minutes. They were then given a surprise forced-choice recognition test that included both pictures from each pair presented side by side, in a different random order for each participant. Participants received the following instructions for the recognition test:

You are now going to see a series of pairs of pictures. For each pair, please indicate which one is the picture that you saw in the rating task. If you believe the picture on the left is *the one you saw earlier, press the z key. If you believe the picture on the right is the one you saw earlier, press the / key. Please respond as quickly and accurately as you can.*

Whether the correct picture appeared on the left or the right was fully counterbalanced across trials. The recognition test was self-paced and the pictures remained on the screen until a response was made.

Results and discussion

Table 2 shows mean study ratings and mean proportions of correct recognition for the three rating conditions. A one-way between-groups ANOVA on study ratings showed a significant main effect of rating task, F (2,87) = 35.70, MSE =.13, $p < .001$, $\eta_p^2 = .45$. Pairwise comparisons showed that pleasantness ratings were significantly higher than ratings in the survival and moving conditions, both $p < .001$. Ratings for survival were also significantly higher than ratings for moving, $p = .004$.

The numbers of studied pictures correctly identified in the forced-choice recognition test were also entered into a one-way ANOVA. A significant main effect of rating task was observed, F (2,87) = 7.03, MSE = 26.13, $p = .001$, $\eta_p^2 = .14$. Pairwise comparisons showed that pleasantness rating led to significantly higher correct recognition scores than both survival, $p = .009$, and moving, $p = .003$. There was no significant difference between the survival and moving conditions, $p = 1$. An ANCOVA with study rating as the covariate also showed a significant main effect of rating task, F (2,86) = 3.12, MSE = 25.97, $p = .049$, $\eta_p^2 =$ .07. Pairwise comparisons showed that pleasantness rating led to significant higher recognition scores than survival, $p = .046$, and numerically high recognition scores than moving, $p = .27$. The difference between survival and moving was not significant, $p = 1$.

The findings of experiment 2 contrast with those of experiment 1 in that rating pictures for pleasantness led to better memory performance than rating them for survival value. Thus, while survival processing enhances memory for pictures, it does not enhance memory for their visual detail. Otgaar et al. (2010) found that pleasantness ratings led to better recall of visual details than survival and moving ratings, but the difference was not statistically significant. We used a more direct of memory for visual detail and found that performance in the pleasantness condition was significantly higher than performance in the survival and moving conditions.

General discussion

The findings from the two experiments reported here indicate that survival processing enhances memory for the verbal labels of pictures but not for visual details of those pictures. Experiment 1 replicated the findings of Otgaar et al. (2010) that survival processing enhances memory for pictures in a free recall test. It was important to replicate this finding given the differences between our pictures and those used by Otgaar et al. In experiment 2, however, when memory was measured by a forced-choice recognition test designed to assess memory for visual detail, performance was highest following pleasantness ratings at study. Thus, the same encoding tasks produced different patterns of results depending on how memory was tested.

Röer et al. (2013) found that participants generated more possible uses for objects in a survival condition relative to a moving home or an afterlife condition. Bell et al. (2014) also found that survival rating instructions that focus on the functions of objects led to higher recall levels than instructions that focused on threat. As noted by Nairne and Pandereida (2016, p.8), “People naturally generate more ideas, or consider more potential uses for objects, when they are assessing the consequences of a survival situation”. The findings of experiment 1 are consistent with the view that survival processing encourages participants to think creatively about the possible uses of objects. The tendency to focus on the use of objects is also indicated by the study ratings from experiments 1 and 2. In both experiments, mean ratings of relevance to the scenario were significantly higher in the survival condition than in the moving condition, which suggests participants found it easier to imagine how an item could be used in a survival scenario than in a moving home scenario.

As discussed in the introduction, richness-of-encoding has been proposed as a proximate explanation of the survival processing effect (see Erdfelder & Kroneisen, 2014). Participants in a survival processing task generate more ideas, which leads to more retrieval cues, relative to participants in other encoding tasks. This account can explain the findings from experiment 1. The findings of experiment 2 are consistent with those of Alban and Annibal (2022) who found that the survival processing effect is influenced by the degree of transfer-appropriate processing between encoding and retrieval tasks. Whereas free recall benefits from the elaborative encoding engendered by survival processing, the forced-choice recognition task used in experiment 2 relies on memory for precise visual detail. Thus, although survival processing can enhance memory for other aspects of an object, such as its location (Nairne et al., 2012), it does not enhance memory for an object's visual appearance. In contrast, rating the pleasantness of the pictures directed attention to their visual appearance, which transfers better to the forced-choice recognition test. This is consistent with the finding of Otgaar et al. (2010) that participants who rated pictures for pleasantness recalled more details of the pictures than participants in survival and moving conditions. Although the difference they observed was not statistically significant, it is consistent with the effects of pleasantness rating observed in experiment 2.

The current findings help delineate some of the boundary conditions of the survival processing effect. As noted by Nairne et al. (2012), this is important in helping us identify the proximate mechanisms that might underpin the effect. In the introduction, we speculated that the ability to remember precise visual detail might confer a survival advantage by aiding the recognition of predators or poisonous fruit. The findings of experiment 2 do not provide evidence for such an advantage. The findings of experiment 1 are consistent with the view that richness-of-encoding is a proximate explanation of the survival processing effect and that thinking about the possible uses of objects creates multiple routes to retrieval. A caveat to this, however, is that a rating task that directs attention to the possible uses of objects does not enhances retentio when tested by a recognition task that relies on memory for visual detail. The findings thus show that the survival processing effect, like many other memory phenomena, relies on an appropriate match between encoding and retrieval processes.

Data Availability Statement

The data supporting this research are openly available from the Open Science Framework archive at https://osf.io/hxqmf/

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Table 1

Means (and standard deviations) of study ratings and correct recall proportions as a function of rating task (survival versus moving versus pleasantness).

	Survival	*Moving*	*Pleasantness*
Study rating	3.34 (.49)	2.81 (.49)	3.68 (.59)
Correct recall	.52 (.11)	.44 (.07)	.40 (.11)

Table 2

Means (and standard deviations) of study ratings and correct recognition proportions as a function of rating task (survival versus moving versus pleasantness).

	Survival	*Moving*	*Pleasantness*
Study rating	2.74 (.34)	2.28 (.34)	3.04 (.37)
Correct recognition	.80 (.08)	.79 (.09)	.86 (.06)