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Surviving with story characters: What do we remember?

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Abstract
Readers simulate story characters' emotions, memories, and perceptual experiences. The current study consists of three experiments that investigated whether survival threat would amplify the mnemonic experience of a narrative. First, a replication study of Nairne et al. (*Journal of Experimental Psychology: Learning, Memory, and Cognition, 33* (2), 263–273, 2007) was conducted with minor methodological alternations and yielded improved recall for participants imagining themselves in a survival scenario over a moving scenario (Experiment 1). In Experiments 2 and 3, participants read stories about a character either stranded in the grasslands or moving to a foreign land. Improved recall for objects included in the story (Experiments 2 and 3) and recognition of story details (Experiment 3) was found when the character was in a survival situation. The largest effects were observed when the reader was asked to imagine themselves as the story character (Experiment 3). Overall, readers remembered survival-relevant details as if they were experiencing the story character's plight. These results extend research showing that survival processing enhances memory for word lists (e.g., Nairne et al., *Psychological Science, 19* (2), 176–180, 2008).

Keywords Adaptive memory · Embodied cognition · Emotion · Reading · Story recall · Survival processing

Introduction

Readers of fiction are often deeply engaged, and are psychologically transported into the fictional world (e.g., Gerrig, 1993; Green & Brock, 2002). Readers see what a character sees (Green et al., 2004), hear what a character hears (Gunraj et al., 2014; Gunraj & Klin, 2012; Klin & Drumm, 2010), and experience a character's emotions, essentially taking a mental journal into the story world. Readers often encode attributes of a scene through a character's perspective, keeping track of the changes in a character's location and the movement of time (Chan et al., 2018; Ditman et al., 2008; Dopkins et al., 1993; Huitema et al., 1993; Levine & Klin, 2001; Magliano & Radvansky, 2001; Rapp & van den Broek, 2005; Zwaan, 1996). In addition, the story character's goals provide a framework for story conflict and influence readers' memory for the narrative (Linderholm et al., 2004; van den Broek et al., 1996, 2003). For example, Houghton and Klin (2019) found that readers had superior memory for a list of words in story when the character committed themselves to remembering the list, rather than glancing at it quickly, even when the list was equally important to the plot in the two versions. Moreover, readers spent twice as long reading the list when the character attempted to commit the words to memory, compared with when the character merely glanced at the list. In a similar study (Gunraj et al., 2017), using a variation of the directed-forgetting paradigm (Bjork, 1970), readers' memory was worse for items presented in the story after a cue that the items were irrelevant to the character's goal. These results suggest that what readers remember is influenced by a story character's cognitive experience.

In addition to influencing what readers remember, readers' emotions are also affected by narrative conflict and character goals (Frijda, 1988; Habermas & Diel, 2010; Hogan, 1997, 2003; Koopman, 2015; Maslej et al., 2021; Oatley, 1999), with emotions contributing to readers' entertainment during reading (Brewer & Lichtenstein, 1982; Schank, 1979). In particular, readers evaluate arousing, negatively valenced stories and characters as interesting and complex (Egidi & Gerrig, 2009; Maslej et al., 2021). Negative emotional events in stories are also remembered more frequently and vividly, and are more

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likely to be transmitted through retellings compared to positive or neutral story events (Bebbington et al., 2016). Similarly, readers encode their own highly arousing, negative autobiographical events vividly, likely due to their potential importance to future events and their usefulness in self-preservation (Ford et al., 2012; Rasmussen & Berntsen, 2009; Rees et al., 2013).

In the current set of experiments, we explore the survival processing effect within the context of narratives. In this well-established paradigm (Nairne et al., 2007), participants are asked to imagine themselves in the grasslands without any basic survival supplies. Then, they are presented with a series of words to rate for survival relevancy. The results of a surprise recall test show enhanced memory for these words compared with any other encoding manipulation that enhances memory (e.g., the generation effect, deep levels of processing, the self-reference effect; see Nairne et al., 2008).

The survival advantage has been found across a range of paradigms, materials, and encoding and testing periods (e.g., Burns et al., 2013; Dhum et al., 2017; Forester et al., 2019; Kang et al., 2008; Kazanas & Altarriba, 2015; Kostic et al., 2012; Kroneisen et al., 2016; Munetsugu & Horiuchi, 2015; Nairne et al., 2009; Nairne & Pandeirada, 2011; Raymaekers et al., 2014; Savine et al., 2011; Weinstein et al., 2008; Yang et al., 2014, 2021). Nairne and Pandeirada (2010) proposed that any information "bathed in the spotlight of survival" benefits from a mnemonic enhancement. Their theory rests on the idea of the evolutionary importance of attending to the survival-related properties of objects and events. Our memory system has evolved to attend to survival information. Consistent with the behavioral findings, there is evidence of enhanced, overlapping brain activation in the amygdala (Calley et al., 2013) and hippocampus (Stout et al., 2018) for threatening images and emotional sentences (Sambuco et al., 2020). Taken together, these studies suggest that stories that contain survival-relevant events may produce a strong mnemonic benefit over other types of non-threatening stories. In spite of many studies on survival processing using word lists, there have been only a few studies that have explored the impact of a survival scenario in memory for narratives. Does the survival processing effect depend on the study participants imaging themselves as being under a survival threat? Or would the findings extend to story characters being described experiencing a survival threat? Previous studies examining survival processing in stories have provided inconsistent results. In one study, Stubbersfield et al. (2015) compared urban legends that contained survival details (e.g., a serial killer uses a recording of a baby crying to lure out women from their homes and kill them) with dry, factual passages. Participants read each story and recalled up to five to six facts. The urban legends with survival details were remembered and retold with greater accuracy than the control passages. Although consistent with a survival account, it should be noted that the stories differed in many ways that may have impacted memorability, including, most likely, how engaging and interesting they were.

A second study to investigate memory in a survival processing story was performed by Otgaar et al. (2013). That study was primarily focused on false memory. When children and adult participants were presented with misinformative, suggestive questions, they were more likely to falsely remember details about the survival story compared with the moving story. Although not the primary focus of the study, the results also showed a survival advantage. Participants in this study read third-person passages centered on either survival or moving. The stories centered around a character who was on a cruise to Hawaii. In the survival condition, his boat crashed, and he landed on a deserted island. In the moving story, he moved to Hawaii, made a friend, and studied biology. In a free recall task, the pattern of results matched that of Stubbersfield et al. (2015); participants had better memory for details of the survival story than the moving story.

In contrast, Seamon et al. (2012) found scant evidence for a survival processing advantage for information presented in stories. Seamon et al. conducted five experiments, four of which presented stories aurally (Experiments 2–5). In one experiment (Experiment 2), an advantage was found for target words presented in a survival-relevant story, and in the other three (Experiments 3–5) an advantage was not found for free recall and cued recall of story facts. The method used in the experiment (Experiment 2) that produced the survival advantage involved re-presenting target words after a given paragraph was read. That is, a word reappeared, separate from the paragraph in which it was initially read, and participants were explicitly asked to rate it for its survival relevance. In subsequent experiments (Experiments 3–5), which did not involve explicit ratings of single words presented outside of the story context, no consistent survival advantage was found in free recall or cued-recall tests for various aspects of the stories.

It is unclear why the survival advantage was not consistently found; however, a few aspects of the study may have contributed to the null results. One factor is that the stories did not contain threat of predators. Kroneisen and Erdfelder (2011) found that removing even one element of the survival threat weakened the recall difference between conditions. Similarly, Olds et al. (2014) added details to the original survival scenario to suggest that food and water would be easy versus difficult to obtain, and predators would be easy versus difficult to detect and avoid. The results demonstrated a linear increase in survival advantage by modifying the extent of the survival threat. Moreover, a meta-analysis by Tay et al. (2019) suggests that the degree of the threat to survival is the largest contributor to the survival advantage. Another influential factor in the Seamon et al. stories may have been that

there was no description of planning for the future, which contrasts with the typical instructions in which participants are prompted to think about how to accomplish goals over some length of time (Nairne et al., 2007). Consistent with this, Klein and colleagues (Klein, 2012; Klein et al., 2011) identified planning as a critical element in producing a survival advantage. For example, memory was improved when participants imagined being stranded without food and were instructed to plan what food to bring with them, compared with when they were instructed that they simply stumbled upon the same set of food items. It should be noted, however, that the study by Otgaar et al. (2013) did not include planning, and yet a survival advantage was found. Finally, survival processing effects, which are extremely robust when the stimuli are words encoded in a list-like fashion (e.g., Nairne et al., 2007), may simply be weaker or less consistent when narratives are used. Although the reason for this potential attenuation would be unclear, we note that such a pattern has been found with other types of process-based encoding manipulations. For instance, imagery instructions, which show pronounced effects on words presented in lists (e.g., Bower, 1970; Paivio, 1969), produce only modest and inconsistent effects when the instructions are applied to narrative texts, such as those used in education (see Dunlosky et al., 2013; Dunlosky & Rawson, 2015). In short, there may be a complex interaction of factors that has left the possibility of a narrative-driven survival advantage in limbo.

The small number of studies on this topic and the conflicting results led us to revisit this question using materials and procedures that were more similar to those used by Nairne et al. (2007), which has produced such robust effects in list memory. In the present study, we ask about the influence of a story character's survival threat on readers' memory. In the current set of experiments, we adhered closely to the scenarios that have been used in survival processing experiments using the word lists as stimuli. The narratives in the current study equated factors such as story structure, wording, and length between conditions to reduce the possibility of confounding factors.

Power analysis

G*Power was utilized to assess statistical power with a level of 0.8 and an alpha level of 0.05 (Faul et al., 2007). The anticipated effect size was medium (n_p^2 = .06 and .09) across all experiments based on a previous meta-analysis of studies that tested memory for word lists (Scofield et al., 2017). Only two groups were planned for this between-subjects design, so converting n_p^2 to Cohen's d, the effect was estimated to fall between d = .51 and .63 (Cohen, 1988). A conservative power analysis revealed an *N* of 128 was needed for two independent groups (d = .5). Data collection aimed to reach this approximate *N*; however, the sample size in Experiment 1 fell somewhat short of this due to difficulties in participant recruitment posed by the COVID-19 pandemic.

Experiment 1

The goal of Experiment 1 was to replicate the survival processing effect with word lists (e.g., Nairne et al., 2007) to ensure that we could find the basic effect using our modified materials. A number of changes were made to the materials and procedure in anticipation of changes that would be necessary in subsequent experiments using narratives instead of word lists. First, the stimuli were inanimate objects that could fit into a backpack (a backpack containing the objects was described in the stories in following experiments). Second, because the critical words had to fit on a single storyline so that reading times could be collected, ten words were used instead of the more typical 30. Third, details of the moving scenario were changed to be more relevant for a college-aged sample – a description of purchasing amenities for a new apartment instead of purchasing a home. Lastly, instead of instructing participants to rate the relevance of each object to the scenario, participants were asked to simply think about whether each object would be relevant for the story character's situation. This change was made to create a more natural reading experience. Previous research has found a survival advantage without using a rating scale during the encoding task (Nairne et al., 2019; Otgaar et al., 2013; Stubbersfield et al., 2015). Based on past research, we predicted that recall of the critical objects would be higher in the survival condition than in the moving condition.

Method

Participants

Participants were 103 undergraduates recruited from Binghamton University during the spring 2020 semester. They received partial course credit in exchange for their participation. Data were collected online.

Materials

Thirty words were retrieved from the MRC Psycholinguistic Database with norming criteria for familiarity, concreteness, imageability, and meaningfulness (350–700). Then, to minimize congruity effects, which is an increased mnemonic benefit for more scenario-relevant words (Butler et al., 2009), 22 participants were recruited to rate the words on a 1–5 Likert scale for their relevance to a survival/moving scenario (1 = totally irrelevant; 5 = totally relevant). Ten of the 30 words (tape, book, doll, pan, wire, quarter, fleece, brush, pin, jewel)

from the norming procedure were selected as experimental stimuli because the mean difference between conditions in ratings was almost zero across the ten words (see Online Supplementary Material (OSM) for the full list of stimuli).

Procedure

Participants were required to use their own computer and access to the internet to begin the experiment via Qualtrics. Participants were instructed to read carefully and focus on the task until the experiment was complete. Participants either received a survival scenario ($n = 44$) or a moving scenario ($n = 50$) and one of the following instructions, which adhere closely to those used by Nairne et al. (2007):

Survival In this task, we 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. We are going to show you a list of items, and we would like you to think about how relevant each of these things would be for you in this survival situation. Some of the items may be relevant and others may not – it's up to you to decide.

Moving In this task, we would like you to imagine that you are planning to move to a new home in a foreign land. Over the next few months, you'll need to pack and transport your belongings and purchase yourself new amenities. We are going to show you a list of items, and we would like you to think about how relevant each of these things would be for you in accomplishing this task. Some of the items may be relevant and others may not – it's up to you to decide.

Each word was presented individually for 5 s in the center of the screen on a white background in 48-pt black font. A 1-s inter-stimulus interval of a white screen appeared between each item. After the last item was presented, a 3-min distractor task was given containing anagrams to solve. Finally, participants were presented with a text box and were instructed to recall as many words as they could remember from the first list. The free recall phase lasted for 3 min, and the whole experiment lasted for approximately 10 min. After they completed the task, participants received a general debriefing.

Results

Data from nine participants were excluded from the analysis due to the participants not following the instructions. Descriptive statistics are summarized in Table 1. Significance criteria were set to $p < .05$, and a two-tailed t-test was used to assess group differences for all experiments.

Table 1 Memory performance for Experiment 1

	Survival		Moving		Difference
	M	*SD*	*M*	*SD*	*M*
Correct recall	60%	20%	51%	19%	9%*
Intrusions	2%	4%	4%	9%	-2%

Note. The * represents significance <.05

Participants in the survival condition recalled more of the words than participants in the moving condition, $t(92) = 2.21$, $p < .05$, $SE_{diff} = .41$, $d = 0.46$.

Discussion

The survival advantage reported by Nairne et al. (2007) was replicated with altered methodology. The effect size of $d = .46$ is somewhat smaller than was found in past research. According to Scofield et al. (2017), the survival processing effect is usually in the range of $d = .51$–$.63$ for a between-subjects design. A smaller effect size could be a consequence of any of our methodological changes – the smaller number of stimuli, the lack of a rating score, or the modified instructions. Further, in the current experiment, the stimuli were inanimate objects, in contrast with animate objects used previously. Animate objects have been found to be mnemonically superior in survival processing (Gelin et al., 2017; but see Kazanas et al., 2020). Typically, a blend of animate and inanimate words is used (e.g., Nairne et al., 2007). Despite the somewhat smaller effect size, we can conclude that the methodological components used previously, such as a rating scale, are not needed to observe a survival advantage.

Experiment 2

In Experiment 2, we examine survival processing in stories. Will readers show the usual memory advantage when they read about a story character experiencing a survival threat? Although the results of previous research examining survival processing in narratives have been mixed (e.g., Otgaar et al., 2013; Seamon et al., 2012), the stories in Experiment 2 will include the factors believed to motivate adaptive memory, such as survival threat and object relevancy to a survival situation (Nairne et al., 2007; Tay et al., 2019).

Despite the smaller effect size ($d = .46$), we originally intended to use the same guidelines from the power analysis presented above ($N = 128$); however, approximately 10% of participants were removed from Experiment 1 for failing to follow directions. Considering the many changes to Experiment 2 (e.g., experiment length, instructions, story comprehension task, etc.) and that the experiment would be

run online again, we conservatively prepared for a potential of 20% participant data removal. Therefore, in Experiment 2, a total *N* of 160 was desired as the addition of 32 participants would protect against 20% of data removal, while still obtaining a minimum target sample. The same justification was used in Experiment 3.

Method

Participants

Participants were 161 undergraduates recruited from Binghamton University during the fall 2020 semester. They received partial course credit in exchange for their participation. Data were collected online.

Materials

A pilot experiment was conducted to help develop the narratives used as the experimental stimuli. The survival and moving stories each contained 268 words and 23 lines (see Appendix 1). Both stories were written in a first-person perspective where the main character is either described as stranded or as moving in immense heat and feeling exhausted. The critical list of objects appeared on a single line (line 20) and was described as a set of objects contained in the main character's backpack. These were the same ten critical words used in Experiment 1. Three story lines followed the set of objects and served as a conclusion of the story. Line lengths across the survival and moving versions were equated within a few letters. The major difference between the stories was the survival elements. For example, in the survival story, the main character is described as being hungry, thirsty, and afraid they could be attacked by predators. In the moving story, the main character is described as being grumpy, grimy, and afraid they could have misplaced some objects during their move.

The experimental passages were preceded by two filler stories written by Annie McMahon (see full stories at https://letterpile.com/creative-writing/flashfictionforeveryone). The first filler story was "Magic Touch," and described a daughter attending her father's magic show. The second was "County Fair Refreshments," and described two siblings in a small town attending a local fair. The filler stories were selected because they didn't contain any survival threat or negative emotional content.

Procedure

Participants joined an online Zoom room where a research assistant greeted them and asked them to remove any distractions. Participants were then assigned to individual breakout rooms where the experimenter gave them a Qualtrics link to the experiment.

The following reading instructions were given, "In this experiment, you will be reading several stories and answering some questions. Stories will be presented one line at a time. Press the [arrow] to advance from line to line. You cannot backtrack. Try to read naturally and pay attention to detail. To answer the questions, use your mouse. Be sure to read and follow all instructions presented on the computer screen."

Participants first read the two filler stories. Story lines were displayed one at a time in 16-pt black font on a white background in the center of the screen, approximately 25% down from the top monitor edge. Participants used their left mouse button to click an arrow to advance to the next line, and the previous line disappeared. The reading times for each line were recorded. After each story, participants answered two true-or-false comprehension questions and rated their level of interest. Then participants read the survival ($N = 72$) or moving ($N = 75$) version of the experimental story. Participants were then asked to recall as many objects from the character's backpack as they could remember. The recall phase lasted for 3 min. Next, three 11-pt Likert scale (0 = not at all, 10 = extremely) questions were asked to assess participants' interest ("how interesting did you find the story?"), arousal ("how emotionally intense did you find the story?"), and threat ("how threatened would you feel if you were actually in the story?"). An 11-pt scale was used to approximate a continuous measurement of these variables (Casper et al., 2020; Huiping & Shing-On, 2017). A final question inquired about multitasking: "Please be honest (this will not affect your participation credit in any way), did you multitask at any point during this experiment?" Due to the lack of environmental control in online studies, this question was used as a data exclusion criterion for those that answered "yes." The experiment took approximately 15 min. Once finished, the participants received a general debriefing.

Results

Memory results

Data were excluded if participants indicated they multitasked ($n = 10$), or had reading times less than 1.5 s for the object list ($n = 4$). The results are summarized in Table 2. Readers showed a mnemonic advantage for the object list in the survival story over the moving story, $t(145) = 2.36$, $p < .05$, $SE_{diff} = .29$, $d = 0.39$. Participants remembered more objects from the main character's backpack after reading a survival story than after reading a moving story.

Table 2 Memory performance, ratings, and reading times for Experiment 2

	Survival		Moving		Difference
	M	*SD*	*M*	*SD*	*M*
Correct recall	33%	19%	27%	15%	6%*
Intrusions	5%	8%	6 %	8%	-1%
Ratings					
Interest	5.0	2.3	3.6	2.1	1.4***
Arousal	4.9	2.3	3.2	1.9	1.7***
Threat	8.1	2.3	4.7	3.0	3.4***
Reading times (ms)					
Story lines	2,708	935	3,020	1,133	-312
Object list line	7,942	6,168	6,393	4,249	1,774

Note. The * represents significance <.05, ** <.01, and *** <.001

Story ratings

Readers rated the survival story higher in interest ($t[145] = 3.62$, $p < .001$, $SE_{diff} = .36$, $d = 0.60$), arousal ($t[145] = 4.8$, $p < .001$, $SE_{diff} = .34$, $d = 0.79$), and threat ($t[145] = 7.81$, $p < .001$, $SE_{diff} = .44$, $d = 1.29$) than the moving story.

Reading times

We did not have a specific hypothesis regarding the reading times for the stories. However, we thought it could be instructive to compare the readings times of the two stories, both overall and on the target-object line. A 2 (story type: survival vs. moving) × 2 (story part: story lines vs. object list line) ANOVA was conducted on participants' reading times. There was no main effect for story type: reading times overall were comparable between the survival story and the moving story, $F(1, 145) = 1.82$, $p > .10$, $MSE = 15.49$, $n_p^2 = .01$. In contrast, there was a main effect for the story part, indicating that the object list line was read more slowly than other story lines, $F(1, 145) = 101.27$, $p < .001$, MSE = 13.44, $n_p^2 = .42$. Critically, there was a significant interaction between story type and story part, $F(1, 145) = 4.73$, $p < .05$, $MSE = 13.44$, $n_p^2 = .03$. This interaction indicates that readers slowed down more on the object list line relative to their overall reading pace in the survival story condition than in the moving story condition.

Further, when examining reading times, we found that the memory advantage was especially pronounced for participants who read the object list slowly. The survival memory effect may be driven by the most engaged readers – those who embody the goals of the story character and evaluate each object in the backpack for its survival value. When data are trimmed for long reading time outliers (1.5x above the top whisker of the measure's boxplot) on the object list line for survival ($n = 7$) and moving ($n = 3$) conditions (> 13.78 s for survival and 14.26 s for moving) to eliminate the trials with the slowest object-line reading times (outliers according to Tukey, 1977), the memory effect is smaller and no longer significant: $M = 30\%$ ($SD = 17\%$) versus $M = 25\%$ ($SD = 15\%$), $t(135) = 1.80$, $p = .07$, $SE_{diff} = .27$, $d = 0.31$ (see OSM).

Discussion

Readers showed a mnemonic advantage for objects presented in a survival story versus a moving story. This result is consistent with the findings of Otgaar et al. (2013), but contrary to the null findings of Seamon et al. (2012). The results suggest that when the story describes a situation in which the character experiences a survival threat, readers embody this experience, which results in enhanced memory. We also found that participants read the object-list line more slowly in the survival story than the moving story. The slowest readers may have been more engaged with the character's plight, embodying the survival experience, as has been found in prior studies (e.g., Houghton & Klin, 2019). Additionally, the object list was likely perceived as a central story detail and relevant to the main character's goal (Christianson & Loftus, 1991; Gunraj et al., 2017; Houghton & Klin, 2019; Loftus et al., 1991). Moreover, participants rated the survival story as more interesting, arousing, and threatening. Unlike threat, interest and arousal are unlikely contributions to typical survival paradigms (e.g., Kang et al., 2008; Nairne & Pandeirada, 2010; Olds et al., 2014), but negatively valenced and arousing stories should be more engaging for readers (Brewer & Lichtenstein, 1982; Maslej et al., 2021), which could influence the likelihood of reader embodiment. Finally, slower reaction times are sometimes observed for rating words in the traditional survival processing experiment for the survival condition (e.g., Butler et al., 2009), which may translate to reading survival-relevant words (i.e., the object list) more slowly. However, the long reaction effect for survival ratings is regularly null and inconsistent (e.g., Burns et al., 2013; Nairne et al., 2009; Weinstein et al., 2008; Yang et al., 2014). Therefore, we suggest that the slower reading of the object list line in the survival condition compared to the moving condition may be a by-product of the more captivating story that the survival-theme offers. Indeed, as described above, the memory advantage was attenuated when we removed the participants who read the target line most slowly. These slow readers also contribute to the large variability in reading times on the object list line, which drove the interaction that reflected a greater slowdown from story line to object list line in the Survival than the Moving condition; the effect is nullified with them removed (see OSM). Presumably these slow readers – like the main character of the story – were considering the survival value of each object, which is what participants

are asked to do in studies on the survival processing effect (e.g., Butler et al., 2009; Kang et al., 2008)

Moreover, we reviewed and reanalyzed the object list from Experiment 2 and discovered that the objects favored the moving condition for relevancy. Concretely, the list of ten words was originally selected by comparing the survival and moving relevancy ratings for each word using mean differences. Summing the ten mean difference scores together, the aggregated the mean difference score of the ten words was near-zero (M_{diff} = -.13). Prior to Experiment 3, a paired t-test was run on the relevancy ratings for each word to determine the effect size of each mean difference score. When summing the ten effect sizes, the result was d = -.89, favoring the moving condition. Additionally, in terms of mean difference and effect size, six of the ten words favored the moving condition. Objects with higher relevancy to a specific condition are also more likely to be remembered better (e.g., Butler et al., 2009). Therefore, the list used in Experiment 3 was revised to minimize survival/moving relevancy differences in terms of effect size, rather than mean difference scores.

Experiment 3

The findings of Experiment 2 demonstrate that adaptive memory processes can be activated through characters and story telling, consistent with Otgaar et al. (2013) and Stubbersfield et al. (2015). In Experiment 3 we tested memory for additional story details beyond the object list line. If survival processing enhances memory for events "bathed in the spotlight of survival" (Nairne & Pandeirada, 2010, p. 18), then other aspects of the survival story should be remembered better than the moving story as well – not just the target line. Therefore, we included a recognition memory test for other story elements.

We made a few additional changes to the passages and the instructions to encourage participants to read deeply and adopt the story character's perspective. First, we changed the narrative perspective. In the previous experiments, a third-person narrative perspective was used (like Otgaar et al., 2013). This is in contrast with some of the previous survival processing experiments, which use a second-person perspective; participants are asked to imagine that they are in the situation and to evaluate how useful each object would be for their own survival. The second-person narrative construction may help readers imagine themselves as the main character and make narrative survival threats more salient. Second, we instructed participants to imagine themselves as the main character, similar to Seamon et al. And third, given that threat is a strong driver of the survival advantage (Olds et al., 2014; Tay et al., 2019), minor revisions were made to amplify the peril of the survival scenario. And finally, we modified the object word list. Previous research has shown that the more relevant a word is to a scenario, the more likely the word will be remembered (Butler et al., 2009). In reviewing our materials, target items were overall more relevant to the moving than the survival scenario. We replaced a few of them to try to achieve a more balanced list.

Method

Participants

Participants were 166 undergraduates recruited from Binghamton University during the spring 2021 semester. They received partial course credit in exchange for their participation. Data were collected online.

Materials

The materials were identical to Experiment 2 other than what is indicated here. To reduce potential boredom and multitasking, only one, 26-line filler story was used. The filler was a nonfiction passage on Bowerbirds, derived from https://animals.sandiegozoo.org/animals/bowerbird. For the survival and moving stories, three lines were added for a total of 26 lines. The object list that participants would later be asked to recall occurred on line 23. Each version of the story was 270 words and 33 words differed between conditions. Any details that could potentially interfere with the participant imagining themselves as the main character were removed (e.g., "1997 Jeep Wrangler" was changed to a vague noun "car" to allow participants to imagine their own car). Extra threat details were added as well (e.g., a "distant roar" by a "beast/truck"). The full stories are presented in Appendix 2.

Additionally, the target list of objects was altered so that the effect size rating differences for each object (obtained from the pilot study described in the methods section of Experiment 1) summed near-zero (d = .09). The new list of objects was "fleece, book, salt, jewel, whistle, camera, paste, ticket, quilt, spoon" (see OSM).

Finally, a seven-question, four-alternative multiple-choice test was developed to assess story memory beyond the embedded list. Multiple-choice selections consisted of one word. Questions and answers were identical for the survival and moving story (e.g., What kind of shoes were you wearing? Sneakers), and presented in the same order. The full multiple-choice test with questions, choices, and answers can be found in the OSM.

Procedure

Participants accessed the study through the experimental participation platform used by the university. The link

randomly assigned them to the survival or moving condition. Participants read either a survival story ($n = 62$) or a moving story ($n = 66$). The procedure was identical to Experiment 2 other than what is noted. Instructions were added before the experimental story: "In this next story, we would like you to imagine yourself as the main character. As you read, process every event as if it were happening to you." Seven four-alternative multiple-choice questions were presented after the free recall of the object list. These addressed a number of details about the story. The timing of the multiple-choice test was self-paced.

Results

Memory results

Data were excluded if participants indicated they multi-tasked ($n = 23$), or had reading times < 1.5 s for the object list ($n = 15$). Descriptive statistics and t-tests are summarized in Table 3. Most critically, readers were more likely to remember the object list in the survival condition than the moving condition, $t(126) = 3.34$, $p = .001$, $SE_{diff} = .37$, $d = 0.59$. In addition, readers of the survival story had higher recognition rate for story details than readers of the moving story, $t(126) = 3.98$, $p < .001$, $SE_{diff} = .25$, $d = 0.70$.

Story ratings

Reader interest did not differ between stories, ($t[126] = 1.83$, $p = .07$, $SE_{diff} = .40$ $d = 0.32$) but the survival story yielded higher ratings of arousal ($t[126] = 2.24$, $p < .05$, $SE_{diff} = .43$, $d = 0.40$), and threat ($t[126] = 4.93$, $p < .001$, $SE_{diff} = .46$, $d = 0.87$). Readers of the survival story reported feeling more emotionally affected and threatened by the content than readers of the moving story.

Table 3 Memory performance, ratings, and reading times for Experiment 3

	Survival		Moving		Difference
	M	*SD*	*M*	*SD*	*M*
Correct Recall	41%	23%	29%	19%	12%**
Intrusions	3%	6%	7%	10%	-4%**
Multiple Choice	84%	17%	70%	22%	-14%***
Ratings					
Interest	5.3	2.3	4.6	2.2	1.7
Arousal	5.3	2.1	4.3	2.7	2.0*
Threat	8.5	1.9	6.2	3.1	2.3***
Reading times (ms)					
Story lines	1,824	794	2,250	1,950	-426
Object list line	9,789	9,938	7,016	4,773	2,773*

Note. The * represents significance <.05, ** <.01, and *** <.001

Reading times

A 2 (story type: survival vs. moving) × 2 (story part: story lines vs. object list line) mixed ANOVA was conducted on the reading times for the stories. Similar to Experiment 2, there was no main effect for story type. Reading times between stories were similar, $F(1, 126) = 2.64$, $p > .10$, $MSE = 33.59$, $n_p^2 = .02$. Moreover, there was a main effect for the story part, indicating that the object list line was read more slowly than other story lines, $F(1, 126) = 91.83$, $p < .001$, $MSE = 28.25$, $n_p^2 = .42$. Finally, there was again a significant interaction between story type and story part, $F(1, 126) = 5.82$, $p < .05$, $MSE = 28.25$, $n_p^2 = .04$. The difference between readings times for the story overall and the target line was greater in the survival story than in the moving story. Readers imagining themselves in the survival story slowed down on the object list line more than readers imagining themselves in the moving story.

Unlike Experiment 2, removing long, outlying times (> 21.09 s for survival and 14.98 s for moving) for the survival ($n = 5$) and the moving ($n = 5$) condition had a negligible effect. The mean recall rates still differed for the two conditions: $M = 40\%$ ($SD = 22\%$) for the survival story versus $M = 28\%$ ($SD = 19\%$) for the moving story; $t(116) = 3.14$, $p < .01$, $SE_{diff} = .38$, $d = 0.58$ (see OSM).

Discussion

The results of Experiment 3 replicated those of Experiment 2; readers have better memory for survival story content than for a moving story baseline. Readers recalled more of the objects in the backpack in the survival version of the story. We also found better memory for the general story details in the survival condition. Notably, readers slowed down on the object list line in the survival story more than the moving story with and without the outlier reading times (see OSM).

General discussion

The mnemonic advantage for stimuli processed according to their survival value has been well established (e.g., Nairne et al., 2007, 2008). Given that readers often embody the experiences of story characters, we asked if a similar survival memory advantage would be found when readers processed survival threats to a story character. Earlier findings have been mixed (Otgaar et al., 2013; Seamon et al., 2012; Stubbersfield et al., 2015). The aim of the current set of studies was to investigate survival processing in stories with better controlled materials and procedures that more closely adhered to those used in previous survival processing studies. In the stories used in the current experiments, the character's survival goal was deeply integrated into the

story. Further, the to-be-remembered items were central to the story, described as objects within the character's backpack. Finally, the passages were well equated across the two versions, with the moving version of the story differing from the survival version only in survival-related details. The two versions were equated as closely as possible for surface level characteristics such as wording, syntax, and length.

In two experiments, we found a survival processing advantage for stories under these conditions. The largest mnemonic effect was observed in Experiment 3 when the story was written in the second person (e.g., You've been marching…), along with overt instructions for the reader to imagine themselves as the character. Although these created a heavy-handed manipulation not found in natural reading situations, it is likely that readers were still less strongly psychologically transported into the story world (e.g., Zwaan, 1999) and less strongly invested in the story characters than they would be when reading an engaging novel. The passages were short and did not involve any of the complexity of real narratives. Despite this, readers' memory was influenced by threats to the story character.

The average effect size for free recall across the two-story experiments was medium ($d = .49$), which corroborates the average effect for a between-subjects design in survival processing (Scofield et al., 2017). The strongest results were achieved when we amplified threat, used second-person narration, instructed participants to imagine themselves in the story, and provided to-be-remembered stimuli with more neutral relevance. Which factors contributed to the increase in effect size from Experiments 2 to 3 is unclear, but there is precedent for the amount of survival threat predicting a mnemonic advantage (e.g., Tay et al., 2019). Moreover, Weinstein and colleagues found a first- and third-person survival advantage for grassland scenarios with comparable results, suggesting that narrative perspective may not be critical to a survival advantage in stories. Indeed, Seamon et al. (2012) used second-person and yielded mostly null results, while Otgaar et al. (2013) used third-person, finding significant effects. The present findings suggest that a story survival advantage is observable regardless of narrative perspective. In this study, we found a 6–12% mnemonic boost over the control narrative with the current materials.

In addition to the memory advantage for objects described in the survival stories, we found that the survival story led to slower reading times on a line describing the character evaluating the objects in the backpack for their survival value than a line describing a character evaluating the objects for their value for a move. It is possible that some participants may have anticipated questions about these items, contributing to the slowdown on the object list line in both conditions. More interesting is that the slowdown in reading and evaluation on the object line was greater in the survival situation than in the moving situation, with or without including the outlying, slow readers. While some reading time variance is likely due to the online experiment, the readers may have been more engaged in the survival story given the arousing and life-threatening context (see Brewer & Lichtenstein, 1982; Maslej et al., 2021; Schank, 1979). That this led to slower reading times suggests that readers may have tracked and embodied the character's emotions and goals (see Huitema et al., 1993; van den Broek et al., 1996, 2003). This work also dovetails with the findings of Houghton and Klin (2019) and Gunraj et al. (2017) in which participants were more likely to remember and forget the same story elements that the story character intended to remember and forget. Further, an advantage was found for recognition of survival-relevant story details that were not contained on the object list line, and, therefore, do not depend on longer reading times, since no differences were found for overall reading times between the two stories.

In our attempt to clarify the mixed results from past work on this topic, we used materials that were better equated across the two story versions. They differed only in the survival portion. The stories were structured similarly and matched for the story character's actions, the structure of the sentences, and the choice of words. The elaboration of the object list was also equated across the two stories. In the survival story, the main character reviewed the objects to analyze how critical each would be to their survival. In the moving story, the main character reviewed how critical the objects would be to their move. In both versions, the object list was integrated into the character's primary goal. Moreover, in contrast with other designs (e.g., Houghton & Klin, 2019), the main character was not described as committing the objects to memory, making this a somewhat subtler manipulation; there was no suggestion to the readers that they should attempt to memorize the items. Rather, the story character simply considered the survival value of each object as it was removed from the backpack.

As noted earlier, our findings of a survival advantage with stories are consistent with Otgaar et al. (2013) but are inconsistent with Seamon et al. (2012). This may have been due to methodological differences between the studies. For instance, Seamon et al. utilized a much longer narrative, which included more temporal and spatial shifts, which may have impaired memory (Ditman et al., 2008; Levine & Klin, 2001; Sundermeier et al., 2005; Zwaan, 1996) and have dissociated the story details from the survival threat. Notably, the stories used in the current study were relatively brief and the survival threat should have been salient throughout.

Another possible factor that led to enhanced memory for the survival details was the immediacy of the threat experienced by the characters. The current stories explicitly described a threat of predators; this was not part of the survival context in the Seamon et al. (2012) study. Consistent with this, the largest effect was found in Experiment 3,

which used stories that magnified the amount of threat experienced by the main character, and encouraged readers to embody that experience, with a second person point of view.

Finally, the design of the current studies closely conforms to the procedures used in previous survival studies using word lists to study survival processing. In particular, the story character evaluates a list of objects according to their survival value. In addition, the experience of the main character in both versions of the story was equated as closely as possible, at the word level as well as in the description of the actions and events. Unlike previous studies, there were minimal story differences other than those directly related to the goal of the study – survival processing.

Overall, the current set of studies suggests that readers have increased memory for the details of stories that focus on a character's survival. Moreover, survival advantage was a found for first-, second-, and third-person perspective, and for unrated story details, corroborating the effect's robustness across changes in materials (Nairne et al., 2019; Weinstein et al., 2008). This adds to the modest set of findings demonstrating better memory for story details that are relevant to survival than to a non-threating situation. Although the survival advantage has been found across a wide range of conditions (e.g., Dhum et al., 2017; Forester et al., 2019; Kang et al., 2008; Kazanas & Altarriba, 2015; Kostic et al., 2012; Kroneisen et al., 2016; Munetsugu & Horiuchi, 2015; Nairne & Pandeirada, 2011; Raymaekers et al., 2014; Savine et al., 2011; Yang et al., 2021), less is known about the survival advantage during story reading. However, given readers are often strongly psychologically transported into the fictional world (e.g., Gerrig, 1993; Green & Brock, 2002), embodying the experiences of the story character, we hypothesized that if the story character was experiencing a survival threat, the reader would be too, leading to the same mnemonic advantage found in previous survival processing experiments. And this is what we found. As Nairne and Pandeirada (2010) proposed, any information "bathed in the spotlight of survival" benefits from a mnemonic enhancement. The current set of results provide further support for the notion that readers simulate character experiences, leading them to embody emotions congruent with the character's emotions (Frijda, 1988; Koopman, 2015; Oatley, 1999), and to remember what the character remembers (Houghton & Klin, 2019). When a story character experiences a survival threat, so does the reader.

Appendix 1 – Experiment 2 materials

Survival story

It is an oppressive day to be stranded in the savannah.

The sun is hot, shining from the clear sky. Sunlight beats down

on the long yellow grass and dry earth. My skin is sweaty.

I have a backpack strapped around my shoulders, lugging around

the last of what I had in my now stalled 1997 Jeep Wrangler.

The dry wind is ruthless sweat starts dripping off my chin,

so I roll up the sleeves on my polo and undo the last button.

The heat is terrible. Thinking is starting to make me tired.

I mop handful after handful of sweat from my bronze brow,

longing desperately for a cold oasis or some shade overhead.

Not far from me, there is a canopy tree under which I could rest.

I'm exhausted. I feel like dozing off the second I sit down.

As I rest, I slide the straps of my backpack off and pull open

the main pocket. I know I will be here for months.

Feeling hungry and thirsty without any basic survival supplies, and

the fear of some big predators attacking, I reach inside my backpack.

One by one, I take out each item and pause with it in my hand,

carefully examining and visualizing how critical each of these things

will be to my survival situation over the next few months:

tape, book, doll, pan, wire, quarter, fleece, brush, pin, jewel.

I shake my head in disbelief. "Is that really everything?" I turn the

backpack upside down and shake nothing out onto the ground.

I sigh and lean back, staring at the canopy above.

Moving story

It is an oppressive day to be moving to Perth, Australia.

The sun is hot, shining through the windows. Sunlight beats down

on the shag yellow carpet and dust bunnies. My skin is sweaty.

I drop the backpack strapped around my shoulders, ready to unpack

the last of what I had in my now parked 1997 Jeep Wrangler.

The dry air is ruthless and sweat starts dripping off my chin,

so I roll up the sleeves on my polo and undo the last button.

The heat is terrible. Thinking is starting to make me tired.

I mop handful after handful of sweat from my bronze brow,

longing desperately for a cold bath or some air conditioning.

Not far from me, there is a folding chair on which I could rest.

I'm exhausted. I feel like dozing off the second I sit down.

As I rest, I slide the straps of my backpack off and pull open

the main pocket. I know I will be here for months.

Feeling grumpy and grimy with more unpacking to accomplish, and

the fear of having misplaced some things, I reach inside my backpack.

One by one, I take out each item and pause with it in my hand,

carefully examining and visualizing how critical each of these things

will be to my living situation over the next few months:

tape, book, doll, pan, wire, quarter, fleece, brush, pin, jewel.

I shake my head in disbelief. "Is that really everything?" I turn the

backpack upside down and shake nothing out onto the ground.

I sigh and lean back, staring at the ceiling above.

Appendix 2 – Experiment 3 materials

Survival story

It is an oppressive day to be stranded in the savannah.

You've been marching without rest for hours.

The sun is hot, shining from the clear sky. Sunlight beats down

on the long yellow grass and dry earth. Your limbs are sore.

You have a backpack strapped around your shoulders,

lugging around the last of what you had in your now stalled car.

The sneakers you wear offer little relief from the dry air.

You mop a handful of sweat from your brow,

longing desperately for a cold oasis or some shade overhead.

Even your backpack is a burden on your aching shoulders,

but it's all you have left.

Not far from you, there is a canopy tree under which you could rest.

You're exhausted. Every one of your footsteps begs for reprieve.

When you reach the tree, the moment you sit down,

you feel like dozing off.

But, the roar of a distant beast keeps your heart pounding.

You slide the straps of your backpack off and pull open

the main pocket. You know you will be here for months.

Already hungry and thirsty without any basic survival supplies, and

the fear of large predators ambushing, you reach inside your pack.

One by one, you take out each item and pause with it in your hand,

visualizing how useful each item will be to your survival:

fleece, book, salt, jewel, whistle, camera, paste, ticket, quilt, spoon.

You shake your head in disbelief. "Is that really everything?" You turn

the backpack upside down and shake nothing out onto the ground.

You sigh and lean back, staring at the tree above.

Moving story

It is an oppressive day to be moving to Perth, Australia.

You've been marching without rest for hours.

The sun is hot, shining through the windows. Sunlight beats down

on the shag yellow carpet and dust bunnies. Your limbs are sore.

You have a backpack strapped around your shoulders,

ready to unpack the last of what you had in your now parked car.

The sneakers you wear offer little relief from the dry air.

You mop a handful of sweat from your brow,

longing desperately for a cold bath or some air conditioning.

Even your backpack is a burden on your aching shoulders,

but it's all you have left.

Not far from you, there is a folding chair on which you could rest.

You're exhausted. Every one of your footsteps begs for reprieve.

When you reach the chair, the moment you sit down,

you feel like dozing off.

But, the roar of a distant truck keeps your heart pounding.

You slide the straps of your backpack off and pull open

the main pocket. You know you will be here for months.

Already grumpy and grimy with more unpacking to accomplish, and

the fear of having misplaced things, you reach inside your pack.

One by one, you take out each item and pause with it in your hand,

visualizing how useful each item will be to your move:

fleece, book, salt, jewel, whistle, camera, paste, ticket, quilt, spoon.

You shake your head in disbelief. "Is that really everything?" You turn

the backpack upside down and shake nothing out onto the ground.

You sigh and lean back, staring at the ceiling above.

Declarations

Conflicts of interest The authors have no known conflict of interest to disclose.

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Open practices statement Data and stimuli used in all experiments are available on the Open Science Framework and can be found at the following link: https://osf.io/n5dgw/?view_only=318905f12f374fb784fd86fbda9dccb9

None of the present experiments were preregistered.