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Crime-Related scenarios do not lead to superior memory performance in the survival processing paradigm

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ABSTRACT

Processing information according to its survival value improves memory retention. We used mass-testing across three experiments to examine whether the survival processing advantage could be extended to crime-related contexts when adopting both offender's (Experiment 1 and 2) and victim's (Experiment 3) perspectives. Interestingly, crime-related scenarios produced the lowest memory retention in Experiments 2 and 3, indicating no mnemonic benefit resulting from crime-related processing. Furthermore, in Experiments 1 and 2, we failed to replicate the standard survival processing effect, while in Experiment 3 the superior survival memory retention emerged in comparison with the standard control conditions (i.e., moving and pleasantness). Overall, our experiments showed that crime-related contexts did not lead to superior memory retention. Moreover, although we detected some failures to replicate the survival processing effect, this evidence is not sufficiently compelling to argue that there was a general absence of the survival processing advantage.

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Adaptive memory; survival processing advantage; crime-related scenario

Processing information according to its survival value (e.g. finding food, avoiding harm) leads to superior memory retention. Specifically, Nairne et al. (2007) designed a series of experiments in which participants were randomly assigned to either a survival, moving or pleasantness scenario. Participants in the survival condition were instructed to imagine themselves being stranded in the grasslands of a foreign land, without any basic survival materials and living there for a few months, while participants in the moving condition were asked to imagine planning to move to a new home in a foreign land and to live there for a few months. Finally, participants in the pleasantness condition were instructed to rate the pleasantness of presented words. All participants were then provided with several unrelated words – presented individually for a few seconds each – and asked to rate the relevance or pleasantness of each word based on the scenario they were assigned to. After engaging in a short distractor task, participants' memory for the rated words was tested through a surprise free recall test. Words processed in the survival scenario were recalled better as compared with words processed in the moving and pleasantness scenarios (Nairne et al., 2007).

The survival processing advantage has earned the reputation of being a robust and reliable memory phenomenon (Nairne et al., 2007, 2012; Nairne & Pandeirada, 2008, 2016). Since Nairne and co-workers' first experiments (2007), the survival processing advantage has been consistently replicated (e.g. Nairne & Pandeirada, 2008, 2010, 2011; Nairne et al., 2012), adopting a variety of stimuli (e.g. pictures; Otgaar et al., 2010), different control conditions (e.g. burglary; Kang et al., 2008; see also Soderstrom & Cleary, 2014) and populations (e.g. children; Aslan & Bäuml, 2012; Otgaar et al., 2010, 2014; elderly adults; Otgaar et al., 2015). Also, Müller and Renkewitz (2015) replicated the

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survival processing advantage as part of the Reproducibility Project.

The ultimate mechanism explaining the survival processing advantage relates to evolutionary psychological theories stipulating that our memory system is "crafted" to help us to retain certain information better than others (e.g. Tooby & Cosmides, 2005). Simply put, our ancestors likely developed and improved the ability to survive by being good at remembering fitness-relevant information (Nairne et al., 2007; Nairne & Pandeirada, 2016). Hence, human's capacity to remember (and forget) information is adaptive in nature. Furthermore, proximate mechanisms can also support the survival processing advantage, emphasising under which conditions such a memory phenomenon could likely be expressed by other more cognitive-related processes (Howe & Derbish, 2014; Howe & Otgaar, 2013). For instance, self-referential processing, distinctiveness, and the impact of arousal and novelty, are potential mechanisms that have been put forward to explain the survival processing advantage. Although some studies showed that when participants were requested to retrieve important personal experiences and then rate how easily the words brought to mind a personal experience, the survival effect vanished (e.g. Klein, 2012), there is evidence for self-referential processing as an important contributor to the survival effect (Nairne & Pandeirada, 2010). Furthermore, distinctiveness with which information is encoded is a crucial factor of processing context (Craik & Tulving, 1975). In this regard, Kroneisen and Erdfelder (2011) suggested that the distinctiveness of the survival context is due to its enhanced unusualness and complexity which in turn leads to more relational processing and superior memory performance as compared with control scenarios (e.g. moving to another city, going on a holiday).

Relatedly, several studies have attempted to design alternative scenarios that would match the survival one in terms of level of arousal and novelty, likely trying to evoke a similar mnemonic benefit due to their distinctive component. For instance, Olds et al. (2014) found that when the survival scenario increased in threat (from low to high), survival participants' memory performance increased as well over control (i.e. modern city context), suggesting that perceived threat contributes to the survival processing advantage (see also Fiacconi et al., 2015). Moreover, even though sometimes rating words according to novel and unusual scenarios (e.g. being attacked by zombies; Soderstrom & McCabe, 2011) led to a better recollection as compared with that exhibited in survival contexts, other studies indicated that the survival mnemonic advantage was still present even when compared with highly novel scenarios (e.g. vs. floating in outer space with dwindling oxygen supplies; Bell et al., 2013). Finally, and of importance for the current study, some studies have adopted scenarios that resembled criminal situations. Kang et al. (2008) created a burglary scenario (i.e. bank heist), used across three experimental studies, that was meant to be equivalent to the survival scenario in terms of excitement and novelty. Still, when compared with the burglary scenario, the survival processing retained its superior advantage. Similarly, Weinstein et al. (2008), found higher recall advantage for the grasslands survival scenario when this was compared with city survival contexts, in which participants were asked to protect themselves from an "attacker".

The current experiments

Despite failing to produce a mnemonic advantage similar to the survival context, the latter crime-related scenarios were mainly designed to further investigate proximate mechanisms underlying the survival processing effect (e.g. Kang et al., 2008; Weinstein et al., 2008). Instead, there might be adaptive reasons for people to remember a criminal experience (Lacy & Stark, 2013). That is, an offender could use prior information in an adaptive manner to guide current or future similar behaviours. Moreover, when people (e.g. victims) are exposed to negative, stressful and/or traumatic situations, typically they are well able to retain information encoded in these contexts (Christianson & Engelberg, 2006), resulting in an adaptive response to cope with these experiences.

With this in mind, we aimed to investigate whether memory performance would be boosted when participants were provided with criminal scenarios. Our idea was that exposing participants to a negative/arousing, and distinctive crime scenario (i.e. committing or being subjected to a crime), would elicit superior memory performance. In other words, we sought to examine whether crime-related processing would be a particularly effective mnemonic technique leading to a memory performance similar to that usually elicited by survival processing. Hence, we designed a new negative and distinctive criminal situation by

adopting either an offender's (Experiment 1 and 2) or a victim's (Experiment 3) perspective. Specifically, drawing on the original design by Nairne et al. (2007), across three experiments, we first wanted to mirror the survival mnemonic advantage within both crime scenarios (i.e. offender's and victim's perspective), thereby testing the generalizability of survival processing mechanisms in crime-related contexts. We expected that participants assigned to the crime scenarios would show similar memory retention to those in the survival scenario and hence outperform participants assigned to the other control conditions. Second, we sought to replicate the standard survival processing advantage, meaning that participants in that scenario would show superior memory retention as compared with those in the other standard control conditions (i.e. moving and pleasantness).

Experiment 1

Method

Participants

An a priori power analysis using G*Power3 (Faul et al., 2007) with a medium to large effect size[1] (f = .30) and power of 0.80 indicated a sample size of 128 participants. A total of 142 undergraduate psychology students were collectively tested for approximately 20 min during a lecture at Maastricht University. Three participants did not complete the free-recall task, while an additional person left the protocol sheet completely blank. For those reasons, those people were excluded, leaving 138 participants for the data analysis [M_{age} = 21.06, SD = 1.90; 75% (n = 104) women]. Participants received a course credit for taking part in our experiment. The study was approved by the ethical committee of the Faculty of Psychology and Neuroscience, Maastricht University. The materials and data sets of the three experiments can be found on the Open Science Framework (https://osf.io/yqgc9/).

Materials

We used 60 words (e.g. *mountain*, *pepper*, *basketball*) from 10 unique categories drawn from the updated Battig and Montague norms (Van Overschelde et al., 2004). Half of the words adopted in the current experiment (i.e. 30) was used also by Nairne et al. (2007). To familiarise participants with the task, the first two words were employed as practice and therefore removed from the analyses.

Design and procedure

We used a between-subjects design with scenario as the independent variable [i.e. survival (n = 33) vs. crime (n = 35) vs. moving (n = 36) vs. pleasantness (n = 34)]. Participants were randomly assigned to one of the four conditions. The dependent variable was the number of correct words reported during the free recall. Each participant received instructions and experimental materials in a paper booklet. After signing the informed consent, participants were invited to work on their sheets individually. To ensure compliance, their performance was carefully monitored by the experimenters. Specifically, the experimenters helped to ensure that participants adhered to one of the following instructions and did not turn a page until explicitly told to do so:.

Survival. **"**In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic materials. Over the next few months, you will need to find steady supplies of food and water and protect yourself from predators. We are going to show you some words on the main screen, and we would like you to rate how relevant each word would be in this survival condition. Some of the words may be relevant and others not – it's up to you to decide."

Crime. "In this task, we would like you to imagine that you are addicted to drugs or gambling and that you are living in a very dangerous neighbourhood. Over the next few months, you will have to physically assault and rob people to make money to supply all your needs. We are going to show you some words on the main screen, and we would like you to rate how relevant each word would be in this crime-related condition. Some of the words may be relevant and others not – it's up to you to decide."

Moving.[2] "In this task we would like you to imagine that you are planning to move to a foreign land with your parents. Over the next few

[1]The effect size we used in our a priori power analysis was similar to the mean partial eta square reported by Scofield et al. in their meta-analysis (2017) for between-subjects experiments (η_p^2 = .09).

[2]Our moving scenario slightly differed from the original one proposed by Nairne and colleagues (2007), in which participants were asked "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" (p. 264).

months, you will need to make new friends and learn a new language. We are going to show you some words on the main screen, and we would like you to rate how relevant each word would be in this moving condition. Some of the words may be relevant and others not – it's up to you to decide."

Pleasantness. "In this task, we are going to show you some words on the main screen, and we would like you to rate the pleasantness of each word. Some of the words may be pleasant and others may not – it's up to you to decide."

Next, participants were shown words that were individually presented on the lecture hall's main screen for 7 s each. Participants were instructed to rate the words according to the scenario they received within that time. That is, participants were asked to circle on a 7-points rating scale (1 = *totally irrelevant or unpleasant*, 7 = *totally relevant or pleasant*), printed on their paper booklet, the rating corresponding to each of the presented word. No mention was made of the upcoming recall task. After rating the words, participants performed a 5-minute distractor task (i.e. spotting differences between two pictures). Following the distractor task, participants were presented with a surprise free recall and were instructed to write down as many words as they could remember from the previous rating task. The surprise free recall lasted 10 min. Finally, participants were thanked and debriefed.

An independent sample of participants ($N = 14$; 71.4% female; $M_{age} = 30$, $SD = 4.11$) rated the crime related scenario in terms of negativity, distinctiveness, plausibility, and arousal as compared with the standard scenarios (i.e. survival and moving). Participants rated their scores on a 5-point Likert scale, ranging from 1 (i.e. not at all) to 5 (i.e. extremely). As compared with the moving scenario, participants found the crime-related scenario more negative ($M_{crime} = 4.43$, $SD_{crime} = 1.22$; $M_{moving} = 1.93$, $SD_{moving} = 1.38$; $p < .001$), distinctive ($M_{crime} = 4.07$, $SD_{crime} = 1.41$; $M_{moving} = 2.86$, $SD_{moving} = 1.46$; $p = .005$), and arousing ($M_{crime} = 4.21$, $SD_{crime} = 1.47$; $M_{moving} = 2.64$, $SD_{moving} = 1.49$; $p = .026$), respectively, while the moving scenario being more plausible than the crime context ($M_{crime} = 1.86$, $SD_{crime} = 1.91$; $M_{moving} = 4.21$, $SD_{moving} = 2.00$; $p = .029$). Yet survival and crime scenarios were rated similarly with respect to negativity ($M_{survival} = 4.07$, $SD_{survival} = .99$; $p = .373$), distinctiveness ($M_{survival} = 4.29$, $SD_{survival} = 1.13$; $p = .512$), plausibility ($M_{survival} = 1.71$, $SD_{survival} = 1.54$; $p = .710$), and arousal ($M_{survival} = 3.79$, $SD_{survival} = 1.31$; $p = .212$).

Results and Discussion

Rating Data

A one-way Analysis of Variance[3] (ANOVA) was performed to examine whether participants in the four scenarios differed with respect to their word rating values. The significant main effect of scenario emerged, $F(3,134) = 8.69$, $p < .001$, $\eta_p^2 = .16$. Pairwise comparisons performed with Tukey's honestly significant difference (HSD) tests revealed that participants in the crime scenario ($M = 2.59$, 95%*CI* [2.34, 2.86]) rated words significantly lower than those in the survival ($M = 3.41$, 95%*CI* [3.16, 3.64]), $p < .001$, *95%CI* [−1.30, -.32], $d = 1.10$, moving ($M = 3.34$, 95%*CI* [3.02, 3.64]), $p < .001$, *95%CI* [−1.22, -.27], $d = .90$, and pleasantness scenarios ($M = 3.23$, *95%CI* [3.08, 3.40]), $p = .003$, *95%CI* [−1.12, -.15], $d = .82$, respectively. Other pairwise comparisons were not statistically significant (all $p_s > .05$).

Correct Recall

A one-way ANOVA was computed on the correct words recalled by participants in the different scenarios. Surprisingly, the main effect of scenario did not reach statistical significance, $F(3,134) = 1.70$, $p = .169$, $\eta_p^2 = .04$, $BF_{10} = .27$.[4] This means that participants' performance in the crime ($M = 28.34$, 95%*CI* [25.86, 31.06]), survival ($M = 30.48$, 95%*CI* [28.33, 32.50]), moving ($M = 28.72$, 95%*CI* [26.89, 30.75]), and pleasantness conditions ($M = 26.82$, 95%*CI* [24.23, 29.22]) did not differ statistically from each other in the number of correct words recalled. See Table 1 for corresponding planned comparisons, and Figure 1 for mean of correct words reported per scenario.

[3]Because the homogeneity of variances was violated as assessed by Levene's test ($p = .016$), we further conducted a non-parametric alternative test to ANOVA (i.e., Kruskal-Wallis test). This analysis revealed similar results, $\chi^2(3) = 55.76$, $p < .001$, meaning that crime-related scenario participants (*Mdn* = 2.51) rated words lower than those in the other groups (survival, *Mdn* = 3.48; moving, *Mdn* = 3.74; and pleasantness, *Mdn* = 3.12, respectively).

[4]All BF_s were calculated using JASP (Marsman & Wagenmakers, 2017) with a standard Cauchy prior and $r_{scale} = 1$. BF_{10} are used to interpreting positive numbers as evidence for the alternative hypothesis. BFs of 1–3 indicate ambiguous evidence for the alternative hypothesis; 3–10 substantial evidence; 10–100 strong evidence; > 100 decisive evidence (Kass & Raftery, 1995).

Table 1. Planned comparisons between scenarios on correct recall (Experiment 1).

	t	*p*	Lower 95%CI	Upper 95%CI	d	BF10
Crime vs. Survival	−1.32	.187	−2.19	6.47	0.31	0.5
Crime vs. Moving	−0.24	.811	−4.61	3.86	0.05	0.25
Crime vs. Pleasantness	−0.94	.345	−2.78	5.82	0.21	0.34
Survival vs. Moving	1.09	.274	−2.54	6.06	0.28	0.44
Survival vs. Pleasantness	2.24	.026	−0.70	8.02	0.55	2.18
Moving vs. Pleasantness	1.19	.236	−2.37	6.17	0.29	0.47

We failed to show any crime-related superior mnemonic effect as well as the standard survival processing advantage (e.g. Nairne & Pandeirada, 2008, 2010, 2011; Nairne et al., 2007, 2012). Even though our crime-related scenario was supposed to be negative and distinctive enough to boost participants' memory performance, our results did not meet our predictions. Arguably, the expected crime scenario mnemonic benefits were not mediated by negativity and distinctiveness.

Furthermore, because we mostly adhered to the standard methodology in the survival processing literature (e.g. Nairne et al., 2007), the failure to replicate survival processing advantage on recall performance was unexpected. Perhaps testing participants collectively might have affected their initial encoding and subsequent retention, although they did receive the instruction to work *individually* and experimenters were alert to this issue as well during the experiment. This, along with other methodological differences with prior studies (e.g. number of words presented, retention interval), could account for the absence of the survival processing advantage in our experiment. Yet another parsimonious explanation for these findings relates to the fact that words were presented in English to participants who were not native English speakers. Indeed, research has shown that emotional processing is influenced by whether the information is processed in the first or second language (e.g. Caldwell-Harris, 2015; Costa et al., 2017).

Experiment 2

Given the unexpected pattern of findings in Experiment 1, we tried to replicate the experiment. We included the previous crime-related scenario (i.e. offender's perspective) in a similar paradigm to the classic survival processing design, increasing the sample size, and presenting words according to our participants' native language.

Method

Participants

Although an a priori power analysis using G*Power3 (Faul et al., 2007) indicated a sample size of 128 participants (see Experiment 1), we recruited a total of 230 undergraduate criminology students. Participants were again collectively tested for approximately 20 min during a lecture at KU Leuven. Two participants were excluded because they left the protocol sheet completely blanked, leaving 228 participants for the data analysis [$M_{age} = 21.22$, $SD = .96$; 67% ($n = 154$) women]. Participants joined our experiment as part of the course in Criminological Psychology. Their participation was entirely voluntary. The study was approved by the Social and Societal Ethics Committee of KU Leuven.

Design, Materials and Procedure

A between-subjects design with scenario as independent variable was used in the current experiment [i.e. survival ($n = 54$) vs. crime ($n = 59$) vs. moving ($n = 59$) vs. pleasantness ($n = 56$)]. All participants were randomly assigned to one of the four conditions. The dependent variable was identical to that of Experiment 1. Moreover, stimulus materials (Nairne et al., 2007; Van Overschelde et al., 2004) and procedure were the same as in Experiment 1. However, this time words were translated into Dutch.

Results and Discussion

Rating Data

We conducted a one-way ANOVA[5] to verify whether participants in the four scenarios differed

[5]Homogeneity of variances was not met as assessed by Levene's test for equality of variances ($p < .001$). However, further examination conducted with Kruskal-Wallis test showed same results, $\chi^2(3) = 134.77$, $p < .001$. Of importance, crime participants ($Mdn = 1.84$) rated words lower than those in the survival ($Mdn = 3.12$), moving ($Mdn = 2.48$), and pleasantness scenario ($Mdn = 4.20$). Other statistically significantly comparisons were also revealed as well as when using Tukey's HSD tests (all $p_s < .001$).

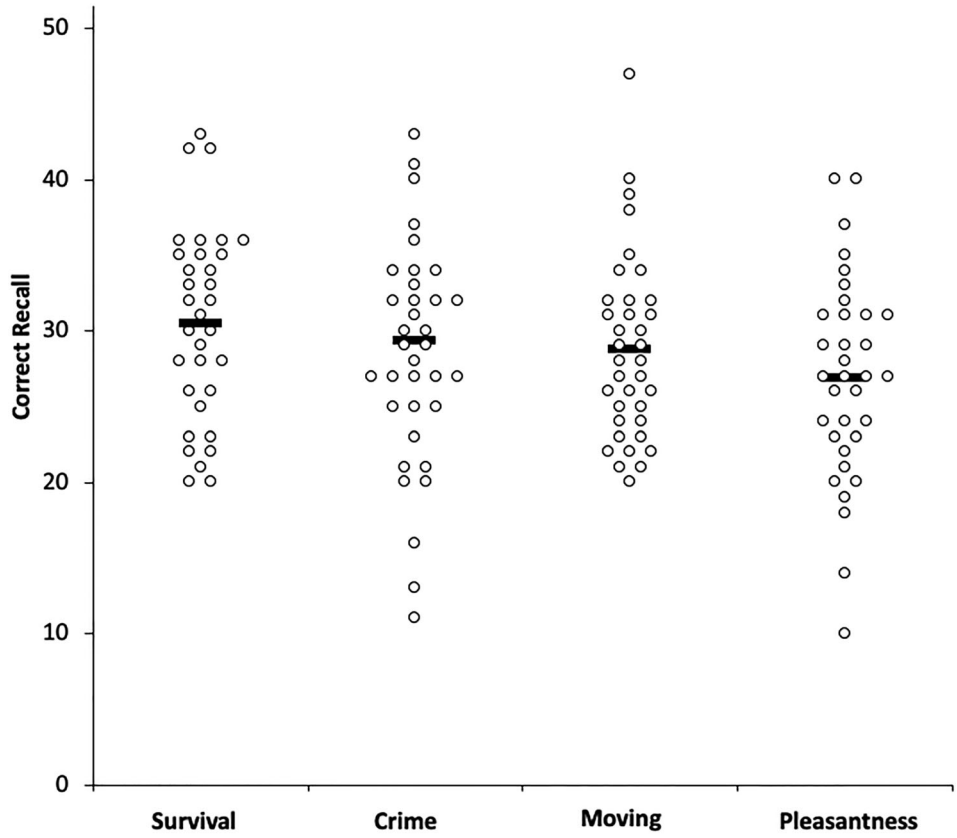

Figure 1. Dot plot representing data distribution of correct recall as a function of scenario. Black bars indicate mean per scenario (Experiment 1).

significantly in their word ratings. The main effect of scenario was statistically significant, $F(3,224) = 110.70$, $p < .001$, $\eta_p^2 = .60$. Pairwise comparisons computed with Tukey's HSD tests indicated that participants in the crime scenario ($M = 1.93$, 95%*CI* [1.78, 2.10]) rated words significantly lower than those in the survival ($M = 3.07$, 95%*CI* [2.90, 3.23]), $p < .001$, 95%*CI* [−1.47, -.79], $d = 1.86$, moving ($M = 2.52$, 95%*CI* [2.28, 2.74]), $p < .001$, 95%*CI* [-.91, -.25], $d = .77$, and pleasantness scenarios ($M = 4.16$, 95%*CI* [4.01, 4.30]), $p < .001$, 95%*CI* [−2.56, −1.89], $d = 3.70$, respectively. Moreover, these latter participants provided higher ratings than those in both survival, $p < .001$, 95%*CI* [.76, 1.43], $d = 1.91$ and moving scenarios, $p < .001$, 95%*CI* [1.31, 1.97], $d = 2.24$. Finally, survival participants rated words significantly higher than those in the moving scenario, $p < .001$, 95%*CI* [.21, .88], $d = .74$.

Correct Recall

A one-way ANOVA[6] performed on words correctly recalled by participants yielded a statistically significant main effect of scenario, $F(3,224) = 4.01$, $p = .008$, $\eta_p^2 = .05$, $BF_{10} = .30$. Planned comparisons showed that participants in the crime-related scenario ($M = 22.41$, 95%*CI* [20.63, 24.18]) recalled fewer correct words than those in survival ($M = 26.56$, 95% *CI* [24.15, 28.96]), moving scenario ($M = 26.03$, 95%*CI* [24.40, 27.66]), and pleasantness scenario ($M = 25.18$, 95%*CI* [23.59, 26.77]). Furthermore, survival participants did not recall significantly more words than those in both moving and pleasantness scenarios. Also, no statistically significant difference was observed between moving and pleasantness participants. Table 2 shows corresponding planned comparisons, while Figure 2 displays the mean of correct words reported per scenario.

[6]Although the homogeneity of variances was violated (Levene's test, $p = .001$), Kruskal-Wallis test revealed an identical pattern of findings, $\chi^2(3) = 10.50$, $p = .035$. Specifically, participants in the crime-related scenario (*Mdn* = .37) reported a fewer correct words than those in both survival (*Mdn* = .43) and moving scenario (*Mdn* = .44). Other statistically significantly differences were not observed (all $p_s > .05$).

Table 2. Planned comparisons between scenarios on correct recall (Experiment 2).

	t	*p*	Lower 95%CI	Upper 95%CI	d	BF10
Crime vs. Survival	2.81	.006	−7.66	-.64	0.52	6.55
Crime vs. Moving	−3.01	.003	−7.06	-.19	0.55	10.70
Crime vs. Pleasantness	−2.32	.022	−6.25	.71	0.43	2.16
Survival vs. Moving	.360	.719	−2.99	4.04	0.06	0.21
Survival vs. Pleasantness	.959	.340	2.18	4.94	0.18	0.30
Moving vs. Pleasantness	.751	.454	−2.63	4.34	0.13	0.25

Overall, in Experiment 2, we again did not observe recall enhancement resulting from participants assigned to the crime-related scenario as compared with the other experimental conditions. Even if we assumed that our crime context would match the survival scenario in terms of novelty, negativity and distinctiveness, processing words according to physically assaulting and robbing other individuals did not lead to mnemonic benefit. Thus, providing participants with a crime scenario did not produce the expected superior mnemonic advantage.

The survival processing advantage emerged only when contrasted to the crime-related scenario. Participants provided with the survival scenario produced a deeper level of processing and consequent superior mnemonic advantage as compared with those in the crime context, in line with previous research adopting other crime-related conditions (e.g. Kang et al., 2008; Weinstein et al., 2008). However, the survival processing effect failed to reach significance when the survival scenario was compared with the standard conditions (i.e. moving and pleasantness). Like we discussed in Experiment 1, given the robustness of the survival processing advantage as shown by prior studies (e.g. Nairne et al., 2007, 2012; Nairne & Pandeirada, 2008), such a failure here might be due to methodological differences between our experiment and the latter studies (e.g. testing collectively, number of words presented, retention interval).

Experiment 3

In Experiment 3, which was conducted in parallel to the previous one, we once again drew our design from Nairne et al. (2007). However, we flipped the crime perspective to that of the victim and asked participants to imagine being assaulted and robbed by drugs or gambling addicts. We created this "alternative" crime scenario to elicit a distinctive crime-related situation that would potentially enhance memory retention. Moreover, we recruited even more participants than in Experiment 2.

The same independent group of participants as in Experiment 1 rated the crime-related scenario from the victim's perspective in terms of negativity, distinctiveness, plausibility, and arousal as pitted against the standard scenarios (i.e. survival and moving), using the same 5-point Likert scale (range 1-5). As compared with the moving scenario, participants considered the (victims') crime-related scenario more negative ($M_{crime} = 4.93$, $SD_{crime} = .99$; $M_{moving} = 1.93$, $SD_{moving} = 1.38$; $p < .001$), distinctive ($M_{crime} = 4.14$, $SD_{crime} = 1.09$; $M_{moving} = 2.86$, $SD_{moving} = 1.46$; $p = .003$), and arousing ($M_{crime} = 4.43$, $SD_{crime} = 1.15$; $M_{moving} = 2.64$, $SD_{moving} = 1.49$; $p = .007$), respectively. Yet crime and moving scenario were rate equally plausible ($M_{crime} = 3.43$, $SD_{crime} = 1.86$; $M_{moving} = 4.21$, $SD_{moving} = 2.00$; $p = .247$). Moreover, despite being evaluated as more negative ($M_{survival} = 4.07$, $SD_{survival} = .99$; $p = .003$), and plausible than survival ($M_{survival} = 1.71$, $SD_{survival} = 1.54$; $p = .008$), the crime context was not found more arousing ($M_{survival} = 3.79$, $SD_{survival} = 1.31$; $p = .058$) and distinctive ($M_{survival} = 4.29$, $SD_{survival} = 1.13$; $p = .720$) than the survival scenario.

Method

Participants

Based on an a priori power analysis using G*Power3 (Faul et al., 2007; see Experiment 1), 128 participants were indicated as the necessary sample size. However, we recruited 306 undergraduate law students. Participants were again collectively tested for approximately 20 min during a lecture at KU Leuven. Seven participants were removed because they did not complete the experiment, leaving 299 participants for the data analysis [$M_{age} = 19.09$, $SD = 2.25$; 77% ($n = 230$) women]. Participants voluntarily engaged in our experiment as part of the course in Legal Psychology. The experiment was approved

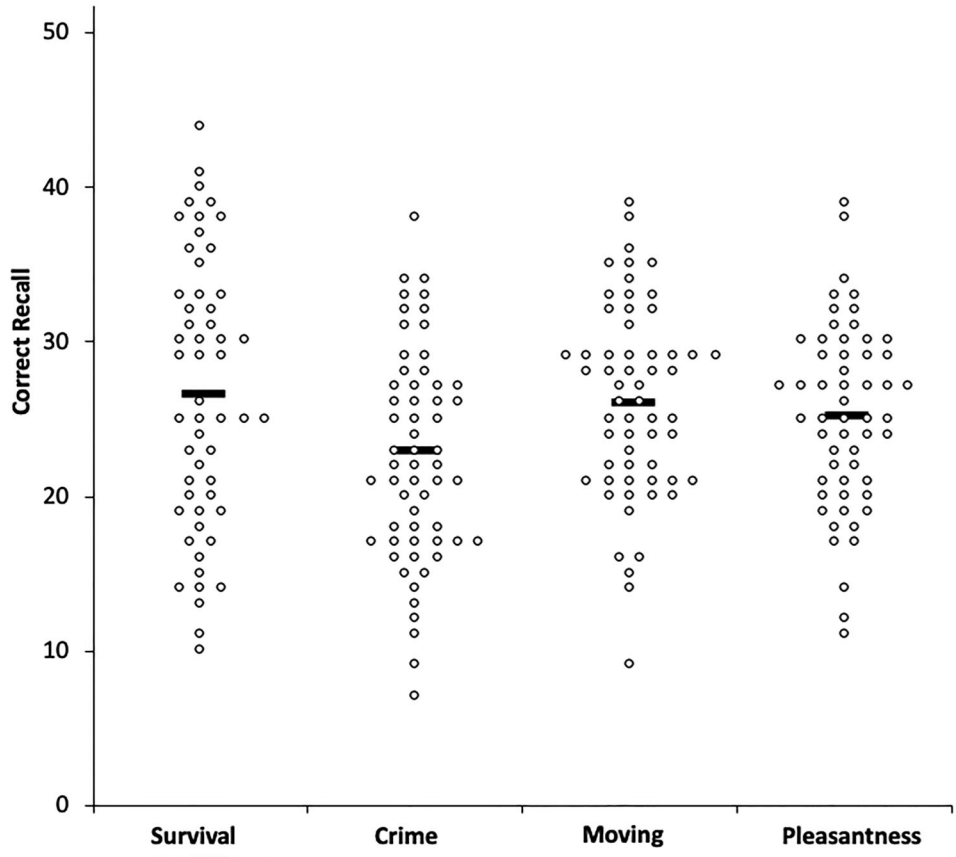

Figure 2. Dot plot representing data distribution of correct recall as a function of scenario. Black bars indicate mean per scenario (Experiment 2).

by the Social and Societal Ethics Committee of KU Leuven.

Design, Materials and Procedure

We adopted a between-subjects design with scenario as the independent variable [i.e. survival ($n = 80$) vs. crime ($n = 69$) vs. moving ($n = 63$) vs. pleasantness ($n = 87$)]. Participants were randomly assigned to one of the four conditions. The dependent variables was identical to that of the prior experiments. Additionally, we also kept the same procedure and stimulus materials previously used in Experiment 2 (i.e. words translated into Dutch; Nairne et al., 2007; Van Overschelde et al., 2004), with the exception of the instruction given to participants in the crime-related scenario. Specifically, in this third experiment, we adopted a victim's perspective. That is, while for participants in the other three conditions the instructions remained the same (see Experiment 1), crime participants received the following scenario:.

Crime. "In this task, we would like you to imagine that you are living in a very dangerous neighbourhood. Over the next few months, you will be physically assaulted and robbed by people addicted to drugs or gambling. We are going to show you some words on the main screen, and we would like you to rate how relevant each word would be in this crime-related condition. Some of the words may be relevant and others not – it's up to you to decide."

Results and Discussion

Rating Data

A one-way ANOVA performed on participants' word ratings revealed the main effect of scenario, $F(3,295) = 111.47$, $p < .001$, $\eta_p^2 = .53$. As in the first two experiments, pairwise comparisons computed with Tukey's HSD tests showed that participants assigned to the crime scenario ($M = 1.97$, 95%*CI* [1.80, 2.16]) provided significantly lower ratings than those in the survival ($M = 3.28$, 95%*CI* [3.12,

3.45]), $p < .001$, 95%*CI* [−1.62, −1.01], $d = 1.78$, moving ($M = 2.81$, 95%*CI* [2.64, 3.02]), $p < .001$, 95% *CI* [−1.17, -.52], $d = 1.15$, and pleasantness scenarios ($M = 4.01$, 95%*CI* [3.87, 4.13]), $p < .001$, 95%*CI* [−2.34, −1.74], $d = 3.01$, respectively. Moreover, pleasantness participants rated words higher than those in both survival, $p < .001$, 95%*CI* [.43, 1.01], $d = 1.06$, and moving, $p < .001$, 95%*CI* [.88, 1.50], $d = 1.77$. Ultimately, participants in the survival scenario rated words significantly higher than those in the moving scenario, $p = .001$, 95%*CI* [.15, .78], $d = .63$.

Correct Recall

We conducted a one-way ANOVA on participants' correct recall. The main effect of scenario emerged, $F(3,295) = 13.96$, $p < .001$, $\eta_p^2 = .12$, $BF_{10} = 1.00$. As for Experiment 2, planned comparisons indicated that, participants in the crime scenario ($M = 24.04$, 95%*CI* [22.25, 25.84]) recalled significantly fewer correct words as compared with those in survival ($M = 31.71$, 95%*CI* [30.05, 33.37]), moving ($M = 29.08$, 95%*CI* [27.53, 30.63]), and pleasantness ($M = 27.98$, 95%*CI* [26.33, 29.63]), respectively. Moreover, survival participants reported significantly more correct words than those both in moving and pleasantness scenarios. Finally, moving participants did not differ statistically from those in the pleasantness scenario. While Table 3 displays corresponding planned comparisons, Figure 3 shows the mean of correct words reported per scenario.

To summarise, the crime scenario-related memory performance of Experiment 3 almost mirrored that of Experiment 2. Their performance on the free recall test was the lowest in that condition. As argued earlier, even by adopting a victim's perspective, novelty, negativity and distinctiveness evoked by this scenario did not eventually improve participants' memory retention as expected.

Still, we succeeded to replicate the survival processing effect. That is, superior recollection emerged when correct recall in the survival group was contrasted with the standard control conditions (i.e. moving and pleasantness), as well as with the crime-related scenario. As several studies suggested (e.g. Nairne et al., 2007, 2012; Nairne & Pandeirada, 2008), processing information from a survival perspective enhanced memory retention. Arguably, moreover, this memory phenomenon can be also supported by the idea that such a scenario provides more distinctive processing (Hunt & McDaniel, 1993) or elicits more arousal. Importantly, this latter experiment was identical to the second one, with the exception of the crime-related scenario's perspective. However, given that the scenarios were manipulated in a between-subjects design, actually there was no difference in the standard conditions (i.e. survival, moving, and pleasantness) between Experiments 2 and 3. Therefore, the difference in the results of these two experiments might be due to chance.

Internal Meta-Analysis

Ultimately, we conducted a mini internal meta-analysis to determine the overall effect sizes of the survival processing advantage observed across our three experiments (i.e. correct words reported). We compared the average main effects size of our experiments with the overall meta-analytic effect size revealed by Scofield et al. (2017) considering between-subjects experiments ($n = 49$; see Table 4). We found that our internal meta-analytic effect size was slightly smaller ($\eta_p^2 = .06$) than the one reported by Scofield et al ($\eta_p^2 = .09$). (2017).

General Discussion

In the current research we aimed to (a) investigate whether crime-related contexts would evince similar mnemonic retention as survival processing and (b) replicate the survival processing advantage (e.g. Nairne et al., 2007, 2012; Nairne & Pandeirada, 2008). To achieve our purposes, we designed two crime-related scenarios (i.e. offender's perspective in Experiment 1 and 2, and victim's in Experiment 3, respectively) to be pitted against standard survival and control processing conditions (i.e. survival, moving, and pleasantness).

To begin, it should be emphasised that by creating negative and distinctive crime scenarios, we expected to boost participants' memory performance to a similar extent as when participants undergo survival processing. That is, because our memory systems may be tuned to encode and retain relevant stimuli in a survival context (e.g. Nairne et al., 2007), we expected that memory would benefit as well from a crime-related processing. Indeed, research has shown that individuals might easily retain negative, stressful and/or traumatic information (e.g. crime; Christianson & Engelberg, 2006) due to its emotional and fitness-relevant component, thereby boosting their memory. Yet across three experiments, our idea regarding

Table 3. Planned comparisons between scenarios on correct recall (Experiment 3).

	t	*p*	Lower 95%CI	Upper 95%CI	d	BF10
Crime vs. Survival	−6.25	< .001	−10.85	−4.49	1.02	2.32
Crime vs. Moving	−4.20	< .001	−8.41	−1.66	0.73	415.03
Crime vs. Pleasantness	−3.20	.001	−7.06	-.81	0.51	17.73
Survival vs. Moving	2.25	.033	−0.63	5.90	0.38	1.82
Survival vs. Pleasantness	3.16	.001	0.73	6.74	0.49	15.99
Moving vs. Pleasantness	.936	.362	−2.10	4.31	0.17	0.26

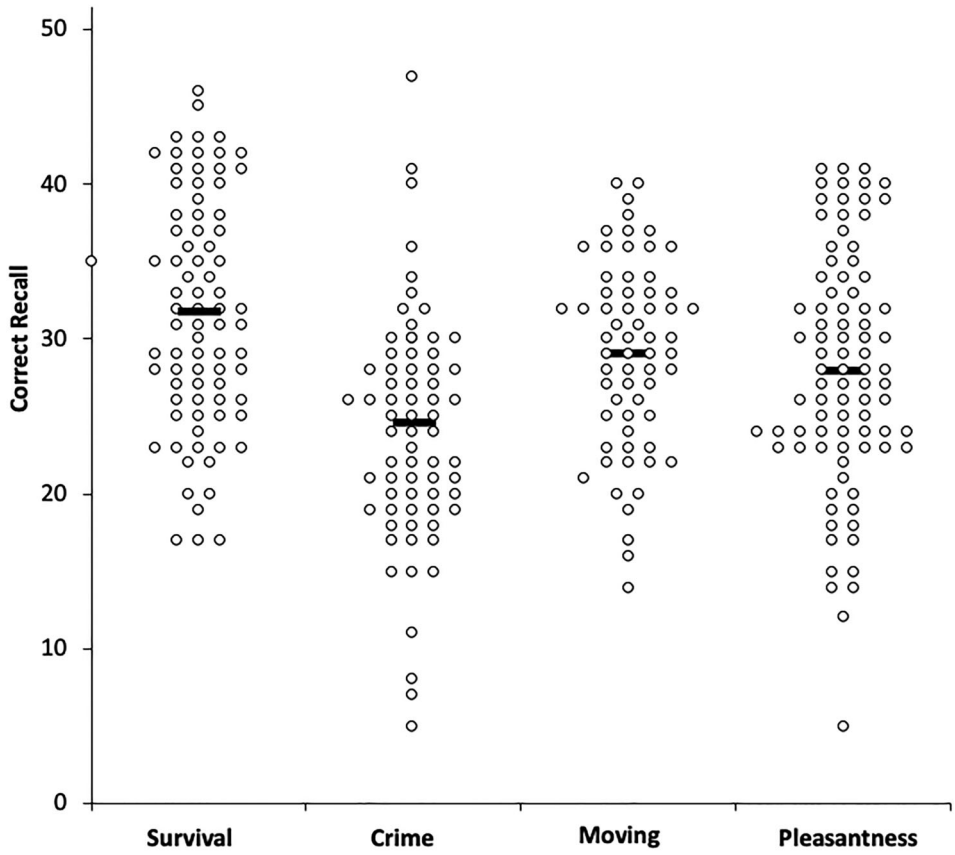

Figure 3. Dot plot representing data distribution of correct recall as a function of scenario. Black bars indicate mean per scenario (Experiment 3).

enhanced crime-related memory was not supported. Thus, from an evolutionary perspective, would this suggest that remembering (and forgetting) stimuli during criminal experiences might not reflect an adaptive function? Based on our data, though, we do not have a definite answer to that question. In this respect, however, we considered crime-related scenarios as a new empirical avenue within the realm of adaptive memory. Our experiments indeed reflect a demonstration of the effects of different imaginary scenarios on memory. Perhaps, because both survival and crime processing might share similar features (e.g. securing life, protection from predators/attackers), future research could further investigate possible survival-processing-like mechanisms in crime-related contexts.

Furthermore, it is also possible that some other proximate mechanisms might account for these participants' poor memory retention as compared with that exhibited by those in the other conditions. For one thing, one might argue that our crime scenarios were not distinctive enough to boost memory retention. For instance, Kroneisen and Erdfelder (2011) manipulated the complexity and distinctiveness of encoding by increasing the number of survival problems addressed in the survival scenario (Experiments 1 and 2) or the number of survival techniques processed per word (Experiment 3). These authors did not find the survival effect

Table 4. Effects size of the three experiments and overall meta-analytic effect size reported by Scofield and colleagues (2017).

	Effect Size (ηp2)	
Experiment 1	.03	
Experiment 2	.05	
Experiment 3	.12	
		Scofield et al. effect size (η_p^2)
Mean Effect Size	$\bar{X} = 0.06$	$\bar{X} = 0.09$
	95%*CI* [.03 .12]	95%CI [.07 .11]

Note: The effect size by Scofield et al. (2017) reported above refer to between-subjects experiments, considering random-effects. Equally, fixed-effects revealed overall meta-analytic effect size of η_p^2= .09, *95%*CI [.07 .10].

when distinctiveness was balanced between scenarios, indicating that distinctive encoding effects are necessary for the survival-based processing advantage to emerge. However, it should be noted that our crime-related scenarios were rated to be overall negative, distinctive and arousing. Hence, it could be the case that the memory performance exhibited by participants in the crime scenarios was perhaps not mediated by those factors. Alternatively, crime participants' weak memory performance might reflect lack of self-referential processing. The self-reference effect attributes mnemonic advantage of information in reference to the individual's self (Symons & Johnson, 1997). Such effects seem to be important for the survival superior retention because of the personal relevance attributed to stimuli in a survival situation (e.g. Cunningham et al., 2013; Klein, 2012). Thus, it might be the case that our crime scenarios have not triggered self-referential processing, subsequently not improving those participants' memory retention more than the other conditions (even though no statistically significantly difference emerged between crime and pleasantness scenarios during experiment 2). Perhaps, more mnemonic advantage would have been observed if the crime-related scenario itself elicited more self-referential processing.

Interestingly, we came across a rather mixed pattern of results concerning the standard survival processing advantage (e.g. Nairne et al., 2007, 2012; Nairne & Pandeirada, 2008). Specifically, in Experiment 1, we did not find statistically significant differences across all the conditions, despite our power analysis being in line with the majority of studies in the memory literature using between-subjects designs. However, that power analysis ($f = 0.30$; $1\text{-}\beta = 0.80$) also suggests that there was a possibility of missing an effect that was arguably numerically present (i.e. the survival condition was indeed associated with the best recall performance). Furthermore, the stimulus material was presented in a foreign language which may have affected the encoding of the words and hence, the memory results. In Experiment 2, the survival condition outperformed the crime scenario, partially replicating the survival advantage effect. Finally, in Experiment 3 the survival processing task demonstrated its superiority when pitted against all the experimental conditions. As argued earlier, the difference in the results between Experiments 2 and 3 might likely be attributed to chance.

Yet it is important to stress that our experiments differed in several ways from the original study by Nairne and colleagues research (2007). The following differences might likely explain the unfavourable conditions for why, in our experiments, the survival mnemonic advantage did not consistently emerge. For instance, more words than usual (i.e. 60 vs. 30) were presented on the lecture hall's main screen (vs. on a computer monitor), and the encoding time per word was longer (i.e. 7s vs. 5s) as well as the retention interval. Arguably, one might point out that a longer list of words should reduce recall, while longer study times should increase it. Perhaps, with longer study times per word, participants in the survival scenario engaged in other types of processing (e.g. item-selection; Butler et al., 2009) besides the context that they were assigned to, therefore negating the superior survival retention. Furthermore, instead of testing participants individually, we tested participants collectively, even though other researchers have used such mass testing as well and did find the survival processing advantage (e.g. Klein, 2012). Based on these differences, it seems clear that the current experiments should not be interpreted as a failure to detect the survival processing effect. In this regard, our results were mixed, and it is not entirely unsurprising that we did not replicate that effect across all three of our experiments.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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