Acta Psychologica 222 (2022) 103459

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy

Realistic context doesn't amplify the survival processing effect: Lessons learned from Covid-19 scenarios☆

Meike Kroneisen [a,b,*], Michael Kriechbaumer [b], Siri-Maria Kamp [c], Edgar Erdfelder [a]

[a] University of Mannheim, Germany
[b] University of Koblenz-Landau, Germany
[c] University of Trier, Germany

ARTICLE INFO

Keywords:
Memory
Survival processing effect
Covid-19
Emotional response
Richness of encoding

ABSTRACT

Imagining being stranded in the grasslands of an unknown territory without basic survival materials and subsequently rating the relevance of words for this situation leads to exceptionally good memory for these words. This survival processing effect has received much attention, primarily because it has been argued to disclose the evolutionary foundations of human memory. So far, only fictitious scenarios were used to demonstrate this effect. To provide a fairer test of emotional response against richness-of-encoding explanations of the effect, we aimed at increasing everyday relevance and realism of the survival scenarios. For this purpose, we created two new Covid-19 scenarios, one focusing on emotional response (Covid-19-emotion) and the other on survival strategy (Covid-19-strategy). Both new scenarios were compared to the classical grassland and moving scenarios typically used to investigate the survival processing effect. In Experiment 1, we observed better memory for the grassland and Covid-19-strategy scenarios compared to the other two, but no significant difference between the former. A descriptively similar result pattern emerged in Experiment 2 for the number of ideas generated on how to use objects in the four scenarios. Theoretical implications are discussed.

Within the field of evolutionary psychology, it has often been claimed that our memory system evolved to solve information-processing problems our ancestors have been confronted with during Pleistocene (Klein et al., 2002). Specifically, memory enables us to behave more appropriately in the future by using information acquired in the past (Klein et al., 2011; Sherry & Schacter, 1987). In line with this idea, several experiments demonstrated particularly good memory for material relevant for certain adaptive ends such as social exchange (e.g., Buchner et al., 2009). Nairne et al. (2007) showed that asking participants to consider the survival value of arbitrary objects within the context of a survival scenario boosts memory for these objects. In the survival processing paradigm, participants are required to imagine being stranded in the grasslands of a foreign land, deprived of food and water, and in danger of predators. A list of items is then presented that participants are asked to rate with respect to their relevance in this survival scenario. In a delayed retention test, words encoded in this scenario are recalled better than words encoded in several control scenarios (Kang et al., 2008; Nairne et al., 2007) or other deep processing tasks (e.g., Nairne et al., 2007; Nairne et al., 2008). This survival processing effect has been replicated frequently (for a review, see Erdfelder & Kroneisen, 2014). The advantage occurs in between- and within-subject designs and with a range of different to-be-remembered materials (e.g., Nairne et al., 2007; Nairne et al., 2012; Otgaar et al., 2010).

According to the selective tuning hypothesis, the survival processing effect is consistent with the idea that human memory has been selectively tuned during evolution to process and retain information that is relevant to fitness and survival (Nairne et al., 2011). Based on the idea that the human brain evolved during Pleistocene (approximately 1.8 million to 10,000 years ago), it should be shaped by selection pressures that characterized this period. Specifically, our cognitive system should be especially equipped to solve problems of hunter-gatherer societies (Nairne, 2010). In line with this reasoning, Weinstein et al. (2008) found a memory advantage when participants evaluated items with respect to their usefulness to evade predators in the grasslands (ancestral environment) but not when evaluating the same items on their usefulness to evade attackers in a city (modern environment). Nairne and Pandeirada

☆ The research reported in this article was supported by grants KR 4545/1-1, KA 4867/1-1, and ER224/3-1 of the Deutsche Forschungsgemeinschaft (DFG) to Meike Kroneisen, Siri-Maria Kamp, and Edgar Erdfelder, respectively.

* Corresponding author at: School of Social Sciences, University of Mannheim, D-68131 Mannheim, Germany.
E-mail address: kroneisen@psychologie.uni-mannheim.de (M. Kroneisen).

https://doi.org/10.1016/j.actpsy.2021.103459
Received 4 February 2021; Received in revised form 26 November 2021; Accepted 3 December 2021
Available online 7 December 2021

(2010) replicated and extended these results. They found a stronger survival processing effect when participants thought about avoiding predators or finding medicinal plants to cure an infection compared to thinking about evading attackers or finding relevant antibiotics to cure an infection.

Soderstrom and McCabe (2011), however, challenged the view that the survival processing effect is limited to ancestral environments. In their experiment, they compared a grassland-predator with a grassland-zombie scenario as well as a city-attacker and a city-zombie scenario. Overall, zombie-processing led to superior memory, despite the fact that zombies were never part of the Pleistocene era. In line with these results, Kostic et al. (2012) found no difference in recall between the ancestral grassland survival and several other survival scenarios, including a lost in space situation. They concluded that ancestral contexts are not necessary to elicit the memory advantage. What is more, Klein (2013) demonstrated that the survival processing memory benefit can occur even when a scenario-induced context is completely lacking. He compared the grassland scenario with a context-free survival situation ("try to stay alive"). Both scenarios produced equivalent levels of recall. Nairne et al. (2019) asked their participants to generate survival situations involving different stimulus words. No additional context was given. They then compared recall rates for these words in comparison to different control conditions, like a pleasantness rating or generating unusual uses for the target items. Still, a stable survival processing advantage was detected. To summarize, it is not entirely clear to what degree or whether at all the survival memory advantage depends on evolutionarily relevant encoding contexts.

Several proximate psychological mechanisms have been discussed that may explain how survival processing eventually leads to better retention (see Erdfelder & Kroneisen, 2014, for a review). Most of them rely either on efficient forms of encoding that benefit later retrieval or on emotional-response effects on information processing.

One hypothesis posits that the unknown grassland environment boosts memory because it elicits negative emotion or arousal. There is evidence that highly emotional stimuli affect attention and memory (e.g., Kensinger, 2007; Kensinger & Corkin, 2003). However, the role of emotions in the survival processing effect appears to be complex. For instance, the survival processing advantage is not mediated by stress (Smeets et al., 2012). Furthermore, it is not the case that the grassland-survival scenario can be seen as more negative than the control scenarios and therefore increases recall rates. Yang et al. (2014) compared survival processing with an emotionally positive (winning a large amount of money in a lottery draw) and a negative (accidently left behind on a foreign land during a cruise) control scenario. Again, a clear survival processing advantage could be found. Also, arousal or excitement per se cannot explain the effect. For example, Kang et al. (2008) tried to create an alternative bank heist scenario comparable in excitement ratings to the grassland-survival scenario. Word recall was still better in the survival condition. Soderstrom and McCabe (2011) found that zombie scenarios were associated with higher arousal levels and were evaluated more negatively in comparison to the predator and attacker conditions. However, the memory benefit for zombie scenarios remained significant, even when statistically controlling for effects of arousal and negativity. Nevertheless, other authors criticized that this zombie scenario likely includes other fitness-relevant components that might have boosted recall, that is, they might also activate threat, death, and disgust systems (e.g., Nairne & Pandeirada, 2016).

Interestingly, Saraiva et al. (2020) found no survival processing advantage when presenting the scenarios in a second language. There is evidence that emotional activation is larger in one's native language in comparison to a second language (see Costa et al., 2017). Based on this result, Saraiva et al. (2020) interpreted the absence of the effect in the second language as indirect evidence that emotionality might be important for the survival processing effect.

Hart and Burns (2012) speculated that mortality salience can explain the positive effect of survival processing on memory. They showed that priming of death-related thoughts prior to providing pleasantness ratings enhances later recall significantly. However, when contrasting a death-related scenario directly against Nairne et al.'s (2007) grassland survival scenario, Bell et al. (2013) found that the latter was associated with better memory than the former. The specific role of threat in the survival paradigm was examined by Olds et al. (2014). In their experiments, threat level was manipulated by asking participants to imagine that food and water are easy versus difficult to obtain, and that predators are easy versus difficult to detect and avoid. They found better memory for the grassland survival scenario when the threat level increased. In contrast, Bell et al. (2015) did not find enhanced recall in the grassland scenario following a threat focus at encoding. They showed that the survival processing effect is fostered by a functional encoding focus. These results are more in line with an alternative explanation of the survival memory advantage, namely, richness of encoding.

According to the richness-of-encoding hypothesis, the relevance rating task implicitly encourages participants to think about different uses of items in a complex survival context. In the later surprise recall task, the thoughts generated in the encoding phase may serve as powerful retrieval cues (Bell et al., 2015; Kroneisen & Erdfelder, 2011; Kroneisen et al., 2013; Kroneisen et al., 2014, 2016; Röer et al., 2013). The richness-of-encoding hypothesis highlights the idea that thinking about using items as tools to achieve one's goals is a central component of the survival processing advantage. Overall, the results of several studies so far supported the importance of richness of encoding for the survival advantage (e.g., Forester et al., 2019, 2020a, 2020b; Klein et al., 2010; Kroneisen et al., 2020; Kroneisen & Bell, 2018).

It is difficult to discuss the evolutionary origins of the survival processing advantage without a precise understanding of the proximate mechanisms producing it. Based on extant research, it seems that arousal, mortality salience and threat cannot be seen as key determinants of the survival processing effect. However, so far, the research field built upon fictitious scenarios without any significance for everyday life, probably running counter to the explanatory power of emotional accounts of the survival processing effect. It is likely that more realistic, personally relevant survival scenarios elicit stronger emotional responses. It is also possible that more realistic survival scenarios foster more thorough and more creative thinking about the usefulness of items. To explore these possibilities, the present study tested how the emotional response and the richness-of-encoding hypotheses can account for effects of more realistic and everyday relevant scenarios vis-a-vis the classical grasslands and control scenarios.

Currently, our societies face unsettling times. Due to the Covid-19 pandemic, most people have become anxious. Worries about one's own life or the life of friends or family members have become part of our everyday lives. We also face an uncertain future because of possible economic breakdowns and their potentially fatal personal consequences (Restubog et al., 2020). Based on the idea that everyone is affected by this pandemic especially in phases of high Covid 19 incidence rates, we used it as a framework for designing more realistic survival scenarios and compared them to the standard grassland survival scenario of Nairne et al. (2007). The emotional response hypothesis would predict that enhanced attention to threat elicited by the thought of mortal danger and the resulting emotional arousal should drive the survival processing advantage. In contrast, if the survival processing effect is a consequence of a functional encoding focus as predicted by the richness-of-encoding hypothesis, then strategic thinking about the next steps to ensure survival should play the crucial role in producing the survival processing benefit. To test these hypotheses against each other, we created two Covid-19 scenarios, one focusing on threat and the resulting fear induced by the pandemic (Covid-19-emotion) and the other on survival strategy (Covid-19-strategy, i.e., participants were encouraged to think about the usefulness of objects to survive in the current pandemic). Both new scenarios were compared to the standard grassland and moving scenarios typically used to investigate the effect.

If the emotional response hypothesis is correct, then the more realistic and everyday-relevant Covid-19 scenarios should produce the strongest emotional responses and, by implication, the highest level of recall, with the Covid-19-emotion scenario outperforming the Covid-19 strategy scenario. In contrast, if the richness-of-encoding hypothesis is correct, everyday relevance and realism of the scenario should be of minor importance. Rather, functional encoding of words should matter, leading to best performance in either the classical grasslands scenario or the new Covid-19-strategy scenario and worse performance in the moving and Covid-19-emotion scenarios.

1. Prestudy

To test our hypotheses, we developed two new Covid-19 scenarios, the first one focusing on the emotional response (Covid-19-emotion) and the second one on survival strategy (Covid-19-strategy). The original scenarios were developed and presented in German and are available at https://osf.io/y6ecm/. Here, English translations are presented.[1]

The Covid-19-emotion scenario reads as follows:

"In this task, we would like you to imagine how you would feel if from one day to the next you were not allowed to go to work, not allowed to leave the house and only allowed to breathe with a protective mask on. All this happens because of a highly contagious virus that spreads all over the world and affects thousands of victims. Not only do people die, but livelihoods are also destroyed and the economy collapses completely. You too are severely affected, financially as well as mentally, due to deaths in your family."

The Covid-19-strategy scenario was described as follows:

"In this task, we would like you to imagine that you suffer from a chronic lung disease. The novel coronavirus has broken out in your hometown and you are a high-risk patient who would most likely die from infection with the virus. You have no relatives, neighbors etc. who can help you. Now you have one last chance to stock up on everything you could need in the coming weeks and months. You will then be locked up in your household for the foreseeable future without any support.".

A prestudy was conducted to assess whether these Covid-19 scenarios are indeed perceived as more realistic, everyday-relevant, and arousing than the grassland-survival scenario used by Nairne et al. (2007).

1.1. Method

In the online prestudy, 38 participants ($M_{\text{age}} = 20.42$, $SD_{\text{Age}} = 1.98$) drawn from a student population comparable to the one used in the main experiments read all four scenarios. The scenarios were counterbalanced across the questionnaire positions (i.e., positions 1, 2, 3, and 4). For each scenario, participants answered three questions on 5-point Likert scales: 1) How realistic is this scenario? (1 [not realistic] - 5 [very realistic]) 2) How relevant for your everyday life is this scenario? (1 [not relevant at all] - 5 [very relevant]) 3) How emotionally stressful is this scenario for you? (1 [not emotionally stressful] - 5 [very emotionally stressful]).

1.2. Results

Mean ratings for each question and scenario are summarized in Table 1. A 4 (Scenario) x 3 (question) within-subjects ANOVA showed a significant main effect of scenario ($F(2.84,105.17) = 61.35$, $p < .001$, $\eta_p^2 = .62$), of question ($F(1.95,72.18) = 22.51$, $p < .001$, $\eta_p^2 = .38$) and a significant interaction ($F(4.93,182.42) = 11.05$, $p < .001$, $\eta_p^2 = .23$). Post hoc tests[2] revealed significant differences among both Covid-19 scenarios and the grassland-survival scenario concerning ratings of closeness to reality ($t(37) \geq 7.13$, $p < .001$; Question 1), everyday-relevance ($t(37) \geq 4.88$, $p < .001$; Question 2), and emotional stress ($t(37) \geq 5.59$, $p < .001$; Question 3). Similarly, both Covid-19 scenarios also differed significantly from the moving scenario with respect to emotional response ($t(37) \geq 5.23$, $p < .001$; Question 3). Both Covid-19 scenarios did not differ from the moving scenario in terms of closeness to reality (Question 1), although the Covid-19-strategy scenario was estimated to be somewhat more unrealistic compared to the moving scenario, $t(37) = -2.38$, $p = .38$, and the Covid-19-emotion scenario was estimated to be somewhat closer to reality than the moving scenario ($t(37) = 1.78$, $p = 1.00$). Concerning everyday-relevance, the Covid-19-emotion scenario ($t(37) = 4.40$, $p < .001$; Question 2) but not the Covid-19-strategy scenario ($t(37) = -0.36$, $p = 1.00$; Question 2) differed from the moving scenario. Both Covid-19 scenarios did not differ significantly from each other concerning the emotional response ($t(37) = 0.48$, $p = 1.00$; Question 3). However, both Covid-19 scenarios did differ from each other in closeness to reality ($t(37) = 4.16$, $p = .001$; Question 1) and in everyday-relevance ($t(37) = 4.76$, $p < .001$; Question 2).

Table 1
Means and standard errors of the means of participants' ratings (1–5) in the prestudy, separately for each scenario and each question.

Scenario	Question	Mean	SEM
Covid-19-emotion	1) Closeness to reality	4.18	0.18
Covid-19-strategy	1) Closeness to reality	3.26	0.19
Grassland-survival	1) Closeness to reality	1.68	0.13
Moving	1) Closeness to reality	3.79	0.19
Covid-19-emotion	2) Everday life relevance	3.97	0.16
Covid-19-strategy	2) Everday life relevance	2.92	0.22
Grassland-survival	2) Everday life relevance	1.84	0.16
Moving	2) Everday life relevance	3.00	0.19
Covid-19-emotion	3) Emotional stress	4.55	0.10
Covid-19-strategy	3) Emotional stress	4.45	0.14
Grassland-survival	3) Emotional stress	3.21	0.22
Moving	3) Emotional stress	3.29	0.17

1.3. Discussion

We conclude that both new scenarios are indeed perceived as more realistic, personally relevant, and emotionally arousing than the standard grasslands scenario. We thus used these scenarios to test our hypotheses outlined above.

2. Experiment 1

2.1. Method

2.1.1. Participants

One hundred and thirty-five participants were recruited online via internet communities. Of these, 131 participants (84 females) fulfilled the criteria for inclusion (i.e., over 18 years, given approval to informed consent, and at least one correctly remembered item). Participants' age ranged from 18 to 82 years ($M = 31.52$, $SD = 14.96$). Notably, the online experiment was conducted in Germany during the first wave of the Covid-19 pandemic (April – June 2020) when incidence rates peaked and the nation experienced a global lockdown.

2.1.2. Design

A complete between-subject design was used. Participants were randomly assigned to one of the four conditions (Condition 1: Covid-19-emotion, $n = 30$, Condition 2: Covid-19-strategy, $n = 36$, Condition 3: grassland survival scenario, $n = 33$, Condition 4: moving scenario, $n = 32$). In each condition, 34 words were presented, including two buffer words at the beginning and at the end of the wordlist each. Recall performance, response latencies, and relevance ratings served as dependent variables. For an omnibus ANOVA F test with $\alpha = 0.05$, $N = 131$, and an

[1] For all reported experiments, data and materials are available via the Open Science Framework (OSF) and can be accessed at https://osf.io/y6ecm/

[2] Holm method of adjustment

effect size of $f = 0.30$ (Erdfelder & Kroneisen, 2014; Scofield et al., 2017), the power to detect a significant difference in mean recall performance among conditions was thus 0.82 (Faul et al., 2009).

2.1.3. Apparatus and materials

Stimulus materials (i.e., words to be rated for their relevance) were taken from Experiment 1 of Nairne et al. (2007) and translated to German. Thus, target words were 30 concrete words from 30 unique semantic categories. To absorb primacy and recency effects typically found in free recall, we added 4 buffer words, two at the beginning and two at the end of the list. Apart from the buffer words, all words were presented in random order. The experiment was conducted online, using SoSci (Leiner, 2020). The grassland-survival and moving scenarios were identical to those used by Nairne et al. (2007). Participants in the Covid-19-emotion and the Covid-19-strategy conditions were instructed as described before. Next, participants in all four groups received the following instruction:

"We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this situation. Some of the words may be relevant and others may not. There is no right or wrong answer - it's up to you to decide."

All materials were presented in German.

2.1.4. Procedure

Depending on the experimental condition, participants were asked to rate words according to their relevance for either the Covid-19-emotion, the Covid-19- strategy, the grassland-survival, or the moving scenario. Stimuli were presented one at a time for 5 s each, and participants were asked to rate the words on a 5-point scale, with 1 indicating "absolutely not relevant" and 5 "extremely relevant" to the current scenario. They had to respond within 5 s. If they did not respond within this time limit, the next word was presented. The rating task was preceded by a short practice trial, in which two words had to be rated for relevance. After the rating task, participants performed a distractor task (i.e., filling-in an unrelated questionnaire) for 8 min and were then unexpectedly prompted with a written free recall test for the words previously processed in the relevance-rating task. There was no time limit for the final recall phase. At the end of the experiment, participants were debriefed and thanked for their participation.

2.2. Results

The significance level was set to $\alpha = 0.05$ for all statistical tests. Relevance ratings were provided for 97.99% of the presented words.

The mean proportions of correct free recall for all scenarios are shown in Fig. 1 ($M_{\text{Covid-19-emotion}} = 0.32$, $M_{\text{Covid-19-strategy}} = 0.40$, $M_{Grassland\text{-survival}} = 0.45$, $M_{\text{Moving}} = 0.35$). A between-subjects ANOVA showed a significant main effect of scenario, $F(3,127) = 4.10$, $p = .008$, $\eta_p^2 = .09$. Planned contrasts revealed significant differences between grassland-survival and moving ($t(127) = 2.41$, $p = .02$), between grassland-survival and Covid-19-emotion ($t(127) = 3.27$, $p = .001$), but not between grassland-survival and Covid-19-strategy, $t(127) = 1.25$, $p = .21$. Furthermore, recall rates differed significantly between both Covid-19- scenarios, $t(127) = 2.12$, $p = .04$.In contrast, differences between moving and Covid-19-emotion on the one hand ($t(127) = 0.89$, $p = .37$) and Covid-19-strategy on the other hand ($t(127) = -1.22$, $p = .22$) were not significant.

Table 2 presents the median response times for the relevance ratings, separately for each scenario. A between-subjects ANOVA revealed no significant main effect of scenario, $F(3,127) = 2.14$, $p = .10$, $\eta_p^2 = .05$.

Fig. 2 displays recall performance as a function of the relevance ratings provided in the encoding phase. Replicating earlier findings (e. g., Kroneisen et al., 2013; Kroneisen & Erdfelder, 2011), higher relevance ratings are associated with higher levels of recall. Controlling for overall recall performance of the participants, the partial correlation between ratings and recall rates was significant for words processed in the Covid-19-emotion scenario ($r = 0.21$; $p < .001$). The same pattern occurs for words processed in the Covid-19-strategy scenario ($r = 0.17$; $p < .001$), the survival scenario ($r = 0.17$ $p < .001$), and the moving scenario ($r = 0.21$; $p < .001$). Furthermore, we also tested whether the average relevance ratings differed among the scenarios (see Table 2 for the mean ratings for each condition). Again, an ANOVA revealed that this was not the case ($F(3,127) = 1.31$, $p = .275$, $\eta_p^2 = .03$).

2.3. Discussion

In Experiment 1, we found no evidence that closeness to reality as represented by new Covid-19 scenarios amplifies the survival processing advantage. In line with the richness-of-encoding account, recall rates did

Table 2
Means and standard error of the means of participants' median rating latencies and average ratings, separately for each scenario.

	Rating latency (ms)	Average Ratings
Scenario	Mean (SD)	Mean (SD)
Covid-19-emotion	1969 (78.10)	2.63 (0.58)
Covid-19-strategy	1855 (71.30)	2.46 (0.60)
Moving	1823 (75.60)	2.51 (0.54)
Survival	2061 (74.50)	2.69 (0.37)

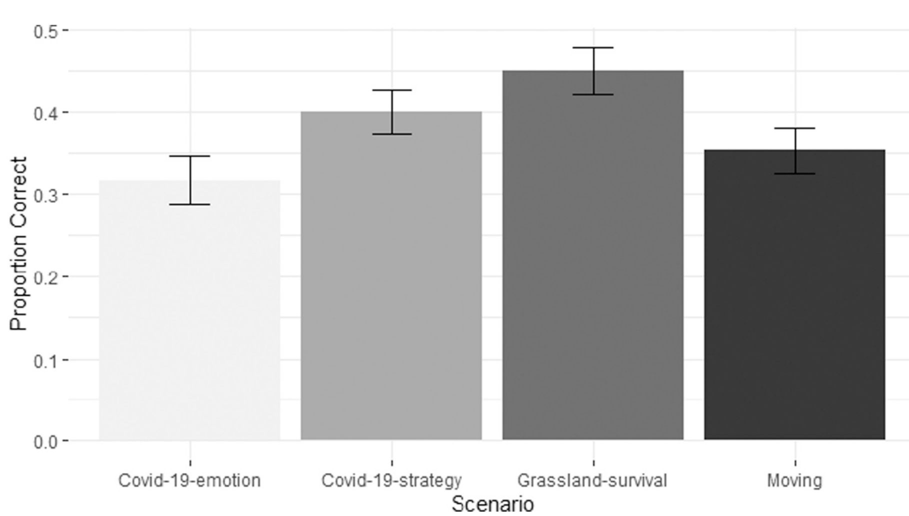

Fig. 1. Mean proportion of correct recall for each scenario. The error bars represent standard errors of the means.

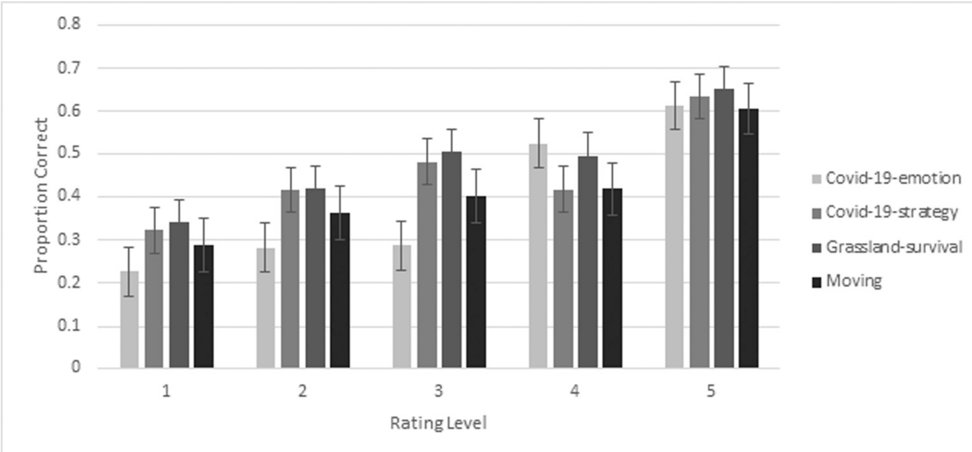

Fig. 2. Mean proportions of correct recall for each scenario, separately for each rating category. The error bars represent standard errors of the means.
To create this figure, we calculated the proportion of correctly recalled words separately for each participant and for each rating category. The figure displays the mean recall rates across participants for different rating categories. Note that the figure does not provide information about the number of items that received each rating in each condition nor does it reveal whether items received similar ratings by the participants. Thus, each bar can reflect the results from different items and may be based on different numbers of items.

not differ significantly between the Covid-19-strategy and the standard grassland-survival scenario. Participants in the Covid-19-emotion and the moving scenario showed lowest recall rates. Especially this latter result is clearly at odds with the emotional response account, according to which the Covid-19-emotion scenario should foster highest recall rates compared to all other scenarios. We found no significant differences in rating times among the scenarios, indicating that differences in processing times cannot explain condition effects on recall performance. In line with other experiments, higher ratings were associated with better recall, irrespective of scenario. Importantly, however, the ratings also did not differ significantly among conditions, indicating that differences in recall among conditions cannot simply be explained by congruency effects (cf. Butler et al., 2009).

According to the richness-of-encoding account, the superior recall performance we observed for both the classical grasslands and the new Covid-19-strategy scenario is due to enhanced functional processing and thus more ideas on possible object uses that came to mind compared to the Covid-19-emotion and the moving control scenario. However, Experiment 1 does not provide any direct evidence on functional processing. Experiment 2 was designed to address this limitation.

3. Experiment 2

As outlined above, according to the richness of encoding hypothesis, functional encoding of words is a key determinant of the survival processing effect. In line with this, Röer et al. (2013) demonstrated that participants generated more ideas when asked to evaluate the usefulness of items within the survival scenario than within survival irrelevant contexts. Our Pre-study showed that both new scenarios are seen as more realistic, relevant, and emotionally arousing than the grassland survival scenario. Experiment 1 demonstrated that the grassland-survival and Covid-19 strategy scenarios produced highest levels of recall compared to the moving and the Covid-19-emotion scenario, suggesting that richness-of-encoding is more important for recall success than realistic context, personal relevance, or the strength of an emotional response to a scenario.

However, does the degree of functional encoding across scenario conditions correspond to the mean pattern of recall rates observed in Experiment 1? In order to address this question empirically, we conducted another experiment similar to Röer et al. (2013, Experiment 2) in which participants were asked to generate ideas on how to use objects in each of the four scenarios, including the two new Covid-19 scenarios. Note, however, that our Experiment 2 was conducted more than a year later than Experiment 1 in June 2021 when the Covid-19 pandemic was ongoing already for 16 months. It therefore seems likely that our participants had become accustomed to the pandemic to some degree so that strong emotional responses are not as likely as they were the year before. This could lower emotional responses to both Covid scenarios and let participants think more calmly and strategically about the situation. Therefore, it is possible that participants in the Covid-19-emotion condition, similar to the Covid-19-strategy condition, engage more strongly in functional encoding of the words than they did the year before.

3.1. Method

3.1.1. Participants

Eighty participants (41 males) were recruited online via Prolific (www.prolific.co). None of these participants took part in the Pre-study or Experiment 1. One participant had to be excluded because he did not provide any idea for more than 16 words. Their age ranged from 18 to 69 years ($M = 31.91$, $SD = 11.98$).

3.1.2. Material

Stimulus materials were the same as in Experiment 1. Thus, target words were 30 concrete words from 30 unique semantic categories.

3.1.3. Design & procedure

Participants were tested online in sessions that lasted approximately 20 min. After providing informed consent, participants responded to several items that requested demographic information. Next, our participants were randomly assigned to one of the four scenarios. After reading the scenario, they were told that they will now see 30 different words. We asked them to consider for each term why it might be useful in the situation just described and to provide us with different ideas of how to use the respective object in this situation. We explicitly told our participants that this task may be easy for some words and harder for others and instructed them to think of as many ideas as possible for each word. No time limits were given. This task was preceded by a short practice trial, in which the participants had to provide ideas for how to use the object "blanket". Then, the 30 words were shown to each participant in a random order. At the end of the experiment, participants were debriefed and thanked for their participation.

3.2. Results

We counted the number of ideas each participant provided (see Table 3). There was a main effect of scenario, $F(3,39.70$[3]$)=4.73$, $p = .006$, $\eta_p^2 = .10$. Planned contrasts revealed that the grasslands survival

[3] Welch correction

Table 3
Means and standard error of the means of participants' generated number of ideas, separately for each scenario.

Scenario	Number of ideas generated Mean (SEM)
Covid-19-emotion	1.74 (0.23)
Covid-19-strategy	1.98 (0.25)
Grassland-survival	2.00 (0.16)
Moving	1.30 (0.12)

scenario stimulated more ideas than the moving scenario, $t(75) = 2.59$, $p = .01$. The Covid-19-emotion and the moving scenario did not differ significantly, $t(75) = 1.60$, $p = .11$. However, there was a significant difference between the Covid-19-strategy and the moving scenario, $t(75) = 2.46$, $p = .02$. Participants generated more ideas in the Covid-19-strategy condition. All pairwise differences among Covid-19-emotion, Covid-19-strategy, and grassland survival scenarios were not significant, $t(75) \leq 0.94$, $p \geq .35$.

3.3. Discussion

In line with Röer et al. (2013), Experiment 2 showed that participants in the grassland-survival condition clearly generated more ideas than participants in the moving condition. When comparing the moving condition with both Covid-19 scenarios, no significant difference emerged between moving and Covid-19-emotion. However, the Covid-19-strategy condition differed significantly from the moving condition. In line with our assumptions, more possible uses of objects came to mind when people thought about the Covid-19-strategy scenario in comparison to the moving scenario. Both Covid-19 scenarios did not differ significantly from each other. However, as discussed above, this experiment was conducted more than a year after Experiment 1 in June 2021. Therefore, strong emotional responses toward Covid-19 were not as likely in Experiment 2 as they were the year before.

4. General discussion

It is reasonable to assume that human memory systems evolved because they helped our ancestors to survive and reproduce (e.g., Klein, 2014; Klein et al., 2002). Consequently, researchers suggested that our capacity to remember is likely tuned to solve fitness-relevant problems (Nairne, 2010). The survival processing effect has been seen as an example of how natural selection shaped our memory systems. To fully understand this effect, it is necessary to learn about the proximate cognitive mechanisms producing this benefit. One prominent class of explanations focuses on the emotional response elicited by survival processing. Another important class focuses on the nature of incidental encoding during the relevance rating task, more specifically, on richness of encoding. For the first class, the relevant literature reports complex and conflicting findings. For the latter explanation, stronger empirical support is available. However, only fictitious scenarios have been used to investigate the survival processing effect so far. A more realistic scenario could elicit stronger emotional responses and thereby produce more compelling evidence in favor of the emotional response explanation. Alternatively, it is also possible that a more realistic survival scenario encourages more strategical reflection about the usefulness of items. To investigate effects of the scenario's closeness to reality and to test the emotional-response against the richness-of-encoding explanation of the survival processing effect, we developed two more realistic Covid-19 scenarios–Covid-19 emotion and Covid-19 strategy–and compared them to the classical grasslands and moving scenarios typically used to establish the survival processing effect.

Experiment 1 showed that closeness to reality does not amplify the survival processing effect. Specifically, we found significantly higher recall rates for both the Covid-19-strategy condition and the grassland-survival condition compared to the Covid-19-emotion condition, with no significant difference between the former two. Furthermore, recall in the Covid-19-emotion condition did not differ significantly from the moving condition. These results are clearly in conflict with the emotional response account that predicts enhanced recall rates especially in the Covid-19-emotion condition. However, they are in line with the richness-of encoding hypothesis suggested by Kroneisen and Erdfelder (2011) because the two scenarios presumably encouraging highest levels of functional encoding performed best in terms of subsequent free recall rates.

Further supporting the idea that survival processing enhances recall by stimulating functional encoding, Experiment 2 replicated the finding of Röer et al. (2013) that the number of object uses that come to mind was significantly larger for the grassland scenario than for the moving scenario. In addition, we found that more object uses came to mind in the Covid-19-strategy scenario than in the Covid-19-emotion scenario, in line with the idea that a functional encoding focus fosters richness of encoding more than an emotional response focus. However, the latter effect was not statistically significant. As discussed above, this may be due to the fact that Experiment 2 was conducted more than a year later than Experiment 1 when people were already accustomed to the pandemic so that the Covid-19-emotion scenario elicits responses similar to those elicited by the Covid-19-strategy scenario. Clearly, the timing of Experiment 2 relative to Experiment 1 is a possible limitation of the current research.

Overall, our results allow for two important conclusions. First, use of more realistic scenarios of high significance for everyday live does not amplify the survival processing effect. Second, superior memory performance in survival scenarios that encourage functional processing of items can best be explained by the richness of encoding account, irrespective of whether scenarios are ancestral (grassland scenario) or more realistic (Covid-19-strategy) in nature.

Declaration of competing interest

None.

References

Bell, R., Röer, J. P., & Buchner, A. (2013). Adaptive memory: The survival processing advantage is not due to negativity or mortality salience. *Memory & Cognition, 41*, 490–502. https://doi.org/10.3758/s13421-012-0290-5

Bell, R., Röer, J. P., & Buchner, A. (2015). Adaptive memory: Thinking about function. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41*, 1038–1048. https://doi.org/10.1037/xlm0000066

Buchner, A., Bell, R., Mehl, B., & Musch, J. (2009). No enhanced recognition memory, but better source memory for faces of cheaters. *Evolution and Human Behavior, 30*, 212–224. https://doi.org/10.1016/j.evolhumbehav.2009.01.004

Butler, A. C., Kang, S. H. K., & Roediger, H. L. I. I. I. (2009). Congruity effects between materials and processing tasks in the survival processing paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*, 1477–1486. https://doi.org/10.1037/a0017024

Costa, A., Vives, M. L., & Corey, J. D. (2017). On language processing shaping decision-making. *Current Directions in Psychological Science, 26*, 146–151. https://doi.org/10.1177/0963721416680263

Erdfelder, E., & Kroneisen, M. (2014). Proximate cognitive mechanisms underlying the survival processing effect. In B. L. Schwartz, M. Howe, M. Toglia, & H. Otgaar (Eds.), *What is adaptive about adaptive memory?* (pp. 172–198). Oxford University Press.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*, 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Forester, G., Kroneisen, M., Erdfelder, E., & Kamp, S.-M. (2019). On the role of retrieval processes in the survival processing effect: Evidence from ROC and ERP analyses. *Neurobiology of Learning and Memory, 166*, Article 107083. https://doi.org/10.1016/j.nlm.2019.107083

Forester, G., Kroneisen, M., Erdfelder, E., & Kamp, S.-M. (2020a). Survival processing modulates the neurocognitive mechanisms of episodic encoding. *Cognitive, Affective, & Behavioral Neuroscience, 20*, 717–729. https://doi.org/10.3758/s13415-020-00798-1

Forester, G., Kroneisen, M., Erdfelder, E., & Kamp, S.-M. (2020). Adaptive memory: Independent effects of survival processing and reward motivation on memory. *Frontiers in Human Neuroscience, 14*, Article 588100. https://doi.org/10.3389/fnhum.2020.588100, 1–13.

Hart, J., & Burns, D. J. (2012). Nothing concentrates the mind: Thoughts of death improve recall. *Psychonomic Bulletin & Review, 19*, 264–269. https://doi.org/10.3758/s13423-011-0211-9

Kang, S. H. K., McDermott, K. B., & Cohen, S. M. (2008). The mnemonic advantage of processing fitness-relevant information. *Memory & Cognition, 36*, 1151–1156. https://doi.org/10.3758/MC.36.6.1151

Kensinger, E. A. (2007). Negative emotion enhances memory accuracy: Behavioral and neuroimaging evidence. *Current Directions in Psychological Science, 16*, 213–218. https://doi.org/10.1111/j.1467-8721.2007.00506.x

Kensinger, E. A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition, 31*, 1169–1180. https://doi.org/10.3758/BF03195800

Klein, S. B. (2013). Does optimal recall performance in the adaptive memory paradigm require the encoding context to encourage thoughts about the environment of evolutionary adaptation? *Memory & Cognition, 41*, 49–59. https://doi.org/10.3758/s13421-012-0239-8

Klein, S. B. (2014). The effects of thoughts of survival and thoughts of death on recall in the adaptive memory paradigm. *Memory, 22*, 65–75. https://doi.org/10.1080/09658211.2012.740486

Klein, S. B., Cosmides, L., Tooby, J., & Chance, S. (2002). Decisions and the evolution of memory: Multiple systems, multiple functions. *Psychological Review, 109*, 306–329. https://doi.org/10.1037/0033-295X.109.2.306

Klein, S. B., Robertson, T. E., & Delton, A. W. (2010). Facing the future: Memory as an evolved system for planning future acts. *Memory & Cognition, 38*, 13–22. https://doi.org/10.3758/MC.38.1.13

Klein, S. B., Robertson, T. E., & Delton, A. W. (2011). The future orientation of memory: Planning as a key component mediating the high levels of recall found with survival processing. *Memory, 19*, 121–139. https://doi.org/10.1080/09658211.2010.537827

Kostic, B., McFarlan, C. C., & Cleary, A. M. (2012). Extensions of the survival advantage in memory: Examining the role of ancestral context and implied social isolation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 1091–1098. https://doi.org/10.1037/a0026974

Kroneisen, M., & Bell, R. (2018). Remembering the place with the tiger: Survival processing can enhance source memory. *Psychonomic Bulletin & Review, 25*, 667–673. https://doi.org/10.3758/s13423-018-1431-z

Kroneisen, M., & Erdfelder, E. (2011). On the plasticity of the survival processing effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 1553–1562. https://doi.org/10.1037/a0024493

Kroneisen, M., Erdfelder, E., & Buchner, A. (2013). The proximate memory mechanism underlying the survival processing effect: Richness of encoding or interactive imagery? *Memory, 21*, 494–502. https://doi.org/10.1080/09658211.2012.741603

Kroneisen, M., Kriechbaumer, M., Kamp, S.-M., & Erdfelder, E. (2020). How can I use it? The role of functional fixedness in the survival processing paradigm. *Psychonomic Bulletin & Review*. https://doi.org/10.3758/s13423-020-01802-y

Kroneisen, M., Rummel, J., & Erdfelder, E. (2014). Working memory load eliminates the survival processing effect. *Memory, 22*, 92–102. https://doi.org/10.1080/09658211.2013.815217

Kroneisen, M., Rummel, J., & Erdfelder, E. (2016). What kind of processing is survival processing? Effects of different types of dual-task load on the survival processing effect. *Memory & Cognition, 44*, 1228–1243. https://doi.org/10.3758/s13421-016-0634-7

Leiner, D. J. (2020). SoSci survey (version 3.2.06-i1142) [computer software]. Available at http://www.soscisurvey.com.

Nairne, J. S. (2010). Adaptive memory: Evolutionary constraints on remembering. In B. H. Ross (Ed.), *Vol. 53. The psychology of learning and motivation: Advances in research and theory* (pp. 1–32). Elsevier Academic Press.

Nairne, J. S., Coverdale, M. E., & Pandeirada, J. (2019). Adaptive memory: The mnemonic power of survival-based generation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 45*, 1970–1982. https://doi.org/10.1037/xlm0000687

Nairne, J. S., & Pandeirada, J. N. S. (2010). Adaptive memory: Ancestral priorities and the mnemonic value of survival processing. *Cognitive Psychology, 61*, 1–22. https://doi.org/10.1037/xlm0000687

Nairne, J. S., & Pandeirada, J. N. S. (2016). Adaptive memory: The evolutionary significance of survival processing. *Perspectives on Psychological Science, 11*, 496–511. https://doi.org/10.1177/1745691616635613

Nairne, J. S., Pandeirada, J. N. S., & Thompson, S. (2008). Adaptive memory: The comparative value of survival processing. *Psychological Science, 19*, 176–180. https://doi.org/10.1111/j.1467-9280.2008.02064.x

Nairne, J. S., Thompson, S. R., & Pandeirada, J. N. S. (2007). Adaptive memory: Survival processing enhances retention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 263–273. https://doi.org/10.1037/0278-7393.33.2.263

Nairne, J. S., VanArsdall, J. E., Pandeirada, J. N. S., & Blunt, J. R. (2012). Adaptive memory: Enhanced location memory after survival processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 495–501. https://doi.org/10.1037/a0025728

Nairne, J. S., Vasconcelos, M., & Pandeirada, J. N. S. (2011). Adaptive memory and learning. In N. M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 118–121). Springer.

Olds, J. M., Lanska, M., & Westerman, D. L. (2014). The role of perceived threat in the survival processing memory advantage. *Memory, 22*, 26–35. https://doi.org/10.1080/09658211.2013.806554

Otgaar, H., Smeets, T., & van Bergen, S. (2010). Picturing survival memories: Enhanced memory after fitness-relevant processing occurs for verbal and visual stimuli. *Memory & Cognition, 38*, 23–28. https://doi.org/10.3758/MC.38.1.23

Restubog, S., Ocampo, A., & Wang, L. (2020). Taking control amidst the chaos: Emotion regulation during the COVID-19 pandemic. *Journal of Vocational Behavior, 119*, Article 103440. https://doi.org/10.1016/j.jvb.2020.103440

Röer, J. P., Bell, R., & Buchner, A. (2013). Is the survival-processing memory advantage due to richness of encoding? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39*, 1294–1302. https://doi.org/10.1037/a0031214

Saraiva, M., Garrido, M. V., & Pandeirada, J. N. S. (2020). Surviving in a second language: Survival processing effect in memory of bilinguals. *Cognition and Emotion*. https://doi.org/10.1080/02699931.2020.1840336

Scofield, J. E., Buchanan, E. M., & Kostic, B. (2017). A meta-analysis of the survival-processing advantage in memory. *Psychonomic Bulletin & Review, 25*, 997–1012. https://doi.org/10.3758/s13423-017-1346-0

Sherry, D. F., & Schacter, D. L. (1987). The evolution of multiple memory systems. *Psychological Review, 94*, 439–454. https://doi.org/10.1037/0033-295X.94.4.439

Smeets, T., Otgaar, H., Raymaekers, L., Peters, M. J. V., & Merckelbach, H. (2012). Survival processing in times of stress. *Psychonomic Bulletin & Review, 19*, 113–118. https://doi.org/10.3758/s13423-011-0180-z

Soderstrom, N. C., & McCabe, D. P. (2011). Are survival processing memory advantages based on ancestral priorities? *Psychonomic Bulletin & Review, 18*, 564–569. https://doi.org/10.3758/s13423-011-0060-6

Weinstein, Y., Bugg, J. M., & Roediger, H. L. (2008). Can the survival recall advantage be explained by the basic memory processes? *Memory and Cognition, 36*, 913–919. https://doi.org/10.3758/MC.36.5.913

Yang, L., Lau, K. P., & Truong, L. (2014). The survival effect in memory: Does it hold into old age and non-ancestral scenarios? *PLoS One, 9*(5), Article e95792. https://doi.org/10.1371/journal.pone.0095792