EXAMENSARBETE

Våren 2015

Sektionen för lärande och miljö
Psykologi

Adaptive Memory: Survival Processing in Ancestral and Fictional Scenarios

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Abstract
The aim of this study was to examine the function behind adaptive memory by comparing groups of participants processing information in ancestral and fictional scenarios related to survival. The thesis was that participants would retain information to a higher extent if processing occurred in a fictional, threatening scenario compared to scenarios based on pleasantness and survival in grasslands. There were four different scenarios, whereas three acted as experimental and one as a control. The comparison was measured by the number of recalled words after a rating process which consisted of rating the relevance of words to survival in respective scenario. Seventy-one participants of differing age were recruited from different parts of the world through social media. They participated by completing a memory experiment on *Explorable.com*. The results showed that there were no significant differences between groups and the number of rated words recalled. The thesis could therefore not be confirmed. No significant difference could be found in rating of the words in the different scenarios. Much research made on the topic of adaptive memory has suggested that participants remember better when processing information in scenarios described as threatening survival in grasslands and during a zombie outbreak. It seems that simple threat to survival does not increase the retention of information. The increased retention found in scenarios related to zombies may not be due to the popularity this subject has in film and games.

Keywords: adaptive memory, fictional scenarios, survival, recall, evolution.

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Adaptive Memory: Survival Processing in Ancestral and Fictional Scenarios

It has been argued by several researchers in the natural sciences that: "The theory of evolution (Darwin, 1859) arguably represents the most influential scientific idea to date" (Soderstrom & McCabe, 2011). During the early 21st century, a new branch of memory research was introduced to psychology called *adaptive memory*. It is defined as the study of memory systems that has evolved to help retain survival- and fitness-related information (Nairne, Thompson & Pandeirada, 2007). To start with, the research was focused around the retention of information in relation to human kind's early survival and adaptation to early environments (Nairne et al., 2007). The focal idea of the theory is that due to Homo sapiens' strife for survival on the savannah and grasslands of Africa during the Pleistocene 1.8 million years ago, it was easier for us to remember vital information if our life was at stake (Tooby & Cosmides, 2012; Nairne et al, 2007; Soderstrom & McCabe, 2011). Our potential for survival would supposedly be greater if we had high-functioning memory systems. The focus of the theory has shifted towards other possibilities than survival and fitness; more specifically, the possible proximal mechanisms that lie behind our improved memory function when processing information through the lens of survival (e.g. Nairne & Pandeirada, 2010; Sandry, Marks, Rice & Trafimow, 2013).

One of the central researchers in the field is James S. Nairne, who has written several papers on the subject. In one of his books he argues that:

> Human memory evolved subject to the constraints of nature's criterion - differential survival and reproduction. Consequently, our capacity to remember and forget is likely tuned to solving fitness-based problems, particularly those prominent in the ancestral environments in which memory evolved (Nairne, 2010, p. 1).

The main question of the theory of adaptive memory is connected to how and why the memory of the human species evolved the way it did. Since we cannot investigate how memory functioned in humans that lived in the past, long ago, we cannot be certain if our memory functions in the same way as it did then. Nairne mentions that our memory and its functions "did not emerge from the mind of a memory theorist – it evolved through a tinkering process called natural selection" (Nairne, 2010, p. 2; Darwin, 1859). By stating this, we can conclude that we are dealing with the rogue element of evolution which leaves us with the task of finding out how memory works without a finished blueprint to guide us. The memory function is still a great mystery when it comes to the proximal mechanisms that drives the improved memory functions in relation to survival. It is argued by many evolutionary biologists and psychologists that memory evolved because it enhanced our possibility to procreate and reproduce. In evolutionary theory, it is argued that all possible mutations that aides a species in its reproduction will be retained by the natural selection criterions (Berkeley University). Therefore, memory functions that helps us in reproduction are valuable and thus maintained. This can of course be considered to be an inductive argument due to our limited knowledge of the earlier memory capacity of our brains.

A central thesis of evolutionary psychology is the idea that our mind, and how it functions, can be compared to the rest of our body and the organs within it that has a special purpose hammered out by the process of natural selection (Nairne, 2010). With that said, there are several potential candidates for "domain-specific mnemonic processes" proposed by Nairne (2010). These are listed as fitness-relevant selection pressures and are divided into five distinct categories: survival-related events, navigation, reproduction, social exchange and kin (Nairne, 2010). A study made by Öhman and Mineka (2001) have found in a consistent manner that people easily

associate stimuli that is fitness-relevant with aversive events. These are often connected with survival and presents themselves in forms of danger or threats. Öhman and Mineka specifically looked at fear and phobias connected to evolution, and how activation in the fear module in humans and non-human primates can assist in remembering locations and situations where fear-inducing or threatening stimuli might occur. Wurm (2007) also found that people are faster at recognizing words that are highly rated on a scale of usefulness to survival relative to matched controls.

One important aspect of researching survival-processing is the use of words unrelated to the actual event. A study done by Guillet and Arndt (2009) used taboo-words, which in themselves often have a positive effect on remembering during a free recall-test due to salience. By exposing participants to words or sentences including neutral, negative-valence, or taboo words they found that the memory for taboo words was enhanced in relation to the other two types. In order to see if survival has anything to do with retention of information, one should use unrelated words in order to avoid conflation of two separate domains of memorization. What is important is how the information is being processed prior to a memory test, and what is relevant is how the information is processed in terms of survival or fitness. This demands a kind of "deep" processing for participants which can yield relevant results separated from other kinds of processing when compared to control conditions. The control conditions in these types of studies are more often than not a rating of pleasantness of the words presented which do not require the same kind of deep processing as more elaborate scenarios (Nairne, 2010).

In Nairne et al. (2007) three conditions were used with a between-subjects design in order to begin the serious research in this field. The three conditions each contained a separate scenario which was to be used for processing words seemingly unrelated to survival. These scenarios was "Survival" and" Moving" used as the experimental conditions, while a rating of "Pleasantness" was used as the control condition. Words processed in the "Moving"-scenario resulted in the lowest rate of memory retention, while "Survival" yielded the highest recall rate. "Pleasantness" resulted in a ca 1 percent higher retention than "Moving". Survival processing yielded significantly higher retention compared to the other two which are considered to be meaningful processing (Nairne et al., 2007). In the same paper a second experiment was presented using the same conditions but instead using a within-subjects design. The results still showed that "Survival" yielded greater retention, even though the words in this condition and the "Moving" condition was almost rated as equally important to the scenario. The free-recall test lasted for ten minutes for each condition. Nairne et al. expected that the survival scenario would yield higher retention due to the fact that "our memory systems may be tuned or biased to help us remember information in a survival context" (2007, p. 269). The important aspect of the pleasantness and moving conditions was that these are targeted towards self-reference which has been shown to be an effective method of retaining information (Nairne et al., 2007). The retention of information was measured in correct words recalled during a free-recall test.

A second study by Nairne, Pandeirada and Thompson (2008) implemented additional conditions in order to get a broader view of how effective survival processing is. There was six different conditions in this study where Survival and Pleasantness was kept from the study mentioned above, with the addition of "Imagery", "Self-reference", "Generation" and "Intentional". The Imagery-condition asked participants to rate the word according to the ease or difficulty these words arouse mental imagery; the Self-reference condition according to the ease or difficulty these words brought important personal experiences to mind; the Generation condition where pleasantness was rated but the first two letters in every word had switched places; and the Intentional learning condition where the participants were simply asked to

memorize the words (Nairne et al., 2008). Once again the results showed that survival processing yielded the best results. One surprising find was that the pleasantness condition yielded lower results than survival, but higher results than all the other conditions (Nairne et al., 2008; Nairne, 2010). The purpose of this study was to pit "… survival processing against conditions that are universally accepted as producing excellent retention…" (Nairne et al., 2008, p. 176).

Since the mechanism of natural selection is closely connected to the field of adaptive memory, most researchers are proponents of the functionalist agenda. This entails that our memory systems are functionally designed, even though it is hard to prove (Nairne, 2010). Cosmida & Tooby (2012) argues that: "the main signs of the functionalist agenda is the Panglossian reasoning that permeates both evolutionary biology and evolutionary psychology" (p. 1). By Panglossian reasoning, they mean that the functionalist explanation consists mostly of "just so"-stories. One of the main goals in the research that has been done lately and is being done is to find the proximal mechanisms which cause the superior retention through survival processing. Panglossian reasoning is therefore not considered to be sufficient, and explanations for the phenomena must therefore be found.

The Functionalist Approach

Why did our memory systems evolve? One of the central ideas of evolutionary psychology is that our memory systems evolved for a reason. There is a function to our memory, and functions that are favourable are maintained due to the process of natural selection. When discussing the functionalist view of memory, there is a problem that is acknowledged throughout the field, which is the non-existence of fossilized memories. We can therefore not find fossilized thoughts and memory processes that would help us study the structures of the memory framework. Another problem is that we have little knowledge of the environment that our ancestors evolved in (Buller, 2005; Nairne, 2010). Since we cannot go back and study the exact environments and neurological structures of our ancestors, there is a difficulty in pinpointing exactly how our memory systems adapted. It is difficult to pinpoint the exact selection pressures that moulded our brains. One contention that is argued by many evolutionary biologists and psychologists is that our minds where mostly developed during the Pleistocene, 1.8 million - 10.000 years ago (Tooby & Cosmides, 2012). The word that is used by e.g. Nairne when it comes to functionalism is *designed*. This does not purport that our memory system was consciously designed by someone, but rather by the selection pressures of natural selection.

In order to establish if our memory systems are functionally designed, we have to test if they are designed to solve adaptive problems which is an empirical question (Nairne, 2010). Our memory systems are not designed to remember everything, but it retains information that is fitness-relevant. The majority of work that is done in the field of adaptive memory assume the functionalist view, meaning that there is some supposed function of our memory systems in relation to our survival.

Ancestral Environment Hypothesis

It has been argued by a multitude of scientists, Soderstrom and McCabe (2011) among others, that the theory of evolution represents the most influential scientific idea to date. It is because of the theory of evolution that memory researchers and evolutionary psychologists have proposed that our memory evolved for survival-fitness. There is a multitude of hypotheses that have been investigated by several researchers in the field of adaptive memory. One of the first and most central that was tested was what e.g. Weinstein, Bugg and Roediger (2008) and Soderstrom and McCabe (2011) call the *ancestral environment hypothesis*. This hypothesis

purports that our memory systems should be sensitive to ancestral priorities in line with evolutionary theory, due to our memory systems being sculpted in line with information and processes relevant to survival (Soderstrom & McCabe, 2011). This is due to natural selection processes that have tuned the human memory system to prioritize processing of fitness-relevant information (Röer, Bell, Buchner, 2012, p. 1). Nairne has proposed that just like the rest of our bodily functions, the structural functions of our memory systems would have been maintained once they arose during the process of our evolution if they enhanced fitness, which is measured by if it raised the chances of survival and the possibility of differential reproduction (Nairne, 2010, p. 2).

Nairne (2010) argues that the footprints of nature's criterion can be easily observed in the physical body. Just as the function and form of our major organs fit tightly, so does the mind's cognitive processes. This is the central thesis of evolutionary psychology. Certain selection processes has carved the functionality of our memory system into what it is today. It has been proposed that our ability to remember and forget plays a large part of how fitness can be improved. If we were to remember everything we learned, it would be harder to prime our thoughts that are needed at a certain point in time. If we were to be in need of locating food or water, it would take us longer if our minds were filled with extraneous thoughts (Nairne, 2010).

The majority of studies that have been made on the subject of adaptive memory has focused on the ancestral environment hypothesis to some extent (Soderstrom & McCabe, 2011; Seamon et al., 2012). The earlier work of Nairne et al. (2007; 2008; 2010) discovered the effect of superior retention after survival processing, and especially if that processing takes place in a grasslands scenario. It has been conjectured post hoc that this effect may be due to our evolutionary history, but this is nothing more than just conjectures (as referred earlier to so-called Panglossian reasoning). One finding that objects to the benefit of survival processing in the grasslands was made in 2011 by Soderstrom and McCabe. They had the traditional scenario of the grasslands, and a control scenario consisting of pleasantness-rating, but they also had a scenario where participants were to process information in a survival scenario consisting of zombies attacking. It was also placed in a more modern context, i.e. a city, and they found that the retention of information was superior to the grasslands scenario. This got much attention in the field and a continued search for a reasonable explanation. More on the possible proximal mechanisms behind this will be discussed in the next section. The ancestral environment hypothesis has been falsified by Soderstrom and McCabe in the manner it was originally proposed, but is still maintained that survival-processing benefits are due to evolutionary processes connected to our past.

Richness of Encoding

The proximate mechanism called richness of encoding, is one of the hypotheses with most support from contemporary research. It is argued by several researchers (Röer et al., 2012; Sandry et al., 2013) that the elaborate encoding that occurs when people process information through the lens of survival, is one of the most important mechanisms that helps people retain information. It seems that the results from most of the research done on fitness-relevant adaptive memory is in line with the hypothesis of richness of encoding. Emotional excitement has not been found to be a satisfactory explanation for the retention advantages in a survival scenario, but the elaborate encoding has bearing in the theory.

Kroneisen and Erdfelder (2011) made an extensive study on the richness of encoding. They discovered that focusing on a single problem, e.g. lack of water, produced poorer recall. It seems that the more narrow the focus is, the less the richness of encoding hypothesis concords with

survival processing. They made a variation on the prominent method of letting participants rate the relevance for each item in the study, and instead let participants give arguments for the relevance of items. It seems that the fewer arguments a participant is allowed to make, the poorer recall it results in.

Röer et al. (2012) explains that the richness of encoding hypotheses: "implies that rating the usefulness of items in a survival context leads to the generation of a large number of ideas that may be used as retrieval cues at test to boost recall" (p. 1). This purports that the more ideas a person can generate which pertains to a piece of information in relation to survival, the easier it is to retrieve the information. The analogy could be made that it is like leaving bread crumbs that a person can follow back to the information when retrieval is needed. With their study, they found that richness of encoding is an important proximate mechanism in the survival-processing paradigm (Röer et al. 2012). This finding is in line with the adaptive character of thought (ACT) model as presented by Anderson (1983).

Deep processing seems to be induced by elaborate encoding, where the different uses for an item stimulates thoughts about how to use an item in different ways. Anderson and Reder, (1979) argued that memory advantage related to deeper processing is due to the number of elaborations participants make when studying material. When a participant makes more elaborations in relation to the material presented, recall is generally improved. An item used in survival scenarios seems to be easy to use for elaborate encoding, which in turn improves the retention of the information given. It has also been found, in relation to this hypothesis, that single target words are more easily remembered when they are embedded in complex sentences, as in contrast to simple ones (Fisher & Craik, 1980). The traditional survival-primed scenario if the grasslands may elicit creativity in the stage of encoding information.

Röer et al. (2012) found that in line with their prediction, participants wrote down more ideas for words in the grasslands survival context than in any of their control scenarios. Further, the recall of these words was greater in this scenario than in the other scenarios, which further supports their richness of encoding hypothesis. As in most of the other studies presented here, Röer et al. (2012) used a surprise free-recall test. The pattern of results seem to indicate that when participants think about the usefulness of items, the greater number of ideas that come to mind, the better the results will be in future recall performance (Röer et al., 2012). One surprising find is that even words that seem completely unrelated to a survival scenario is easily remembered in a grasslands survival scenario than in the control scenarios. Röer et al. gives the example of the word "football" that was used in their experiment as totally irrelevant to a survival advantage, but the thought of playing football with a predator might elicit an absurd dimension. The absurd dimension of encoding seems to stick well to memory, as is in line with the so called *von Restorff* effect (von Restorff, 1933). The absurd dimension discussed by von Restorff might play a role in the superior recall found in experiments related to processing information in fictional scenarios.

Death and Disgust

Reflecting on the ancestral environment hypothesis, it is not supported when compared to Soderstrom and McCabe's added zombie scenario (2011). Modern processing scenarios should not yield higher recall rates, but in this case this one does. All survival scenarios led to better recall than the pleasantness control condition, and those scenarios that included zombies as the threat factor yielded the highest recall of them all. One thing to mention is that this could not be explained by differences in emotional processing. Possible congruency effects where ruled out by comparing relevance ratings between the scenarios, which did not differ, and all the

scenarios included the same words that were to be rated. The zombie scenario was however more arousing than the other scenarios in the study, but not enough to account for the effect found. The responsible mechanism for the advantage was therefore not assumed to be due to emotional processing.

One of the mechanisms that was suggested by Soderstrom and McCabe was instead the activation of *death and disgust systems* (2011, p. 568), which in turn make the threat of zombies more salient. When compared to words like "attackers" or "predators" that was used in the other scenarios, "zombies" are argued to evoke more specific imagery than the other two that can be received as being more abstract than a concrete noun like zombies. It is also possible that the popularization of zombies in film and comics might make them more salient to modern humans than the other two mentioned. It is however hard to find concrete evidence that this is so. It is clear from this research that the ancestral environment hypothesis is not necessarily the angle we want to continue explore this phenomenon from. Other factors may play a part, such as elaborate encoding, self-preservation and predator avoidance systems. It is important to emphasize however that this does not say that ancestral priorities did not play a large part in shaping our memory systems, but rather that scenarios related to ancestral environments might not be the optimal way to test the idea of adaptive memory (Soderstrom & McCabe, 2011). Our ability to process fitness-relevant information may be dynamic, just as environments. It may also be that survival processing is context independent due to the seeming ability of quick and broad spread of our species.

For instance, Soderstrom and McCabe (2011) were able to show that increasing the threat level of the scenarios by exchanging the word "predators" with "zombies" led to a reinforcement of the effect. Given that predation has always been an important force in the evolution of mammals, the threat hypothesis points to a possible role of a threat module of ancient evolutionary origin, which may be located in phylogenetically old subcortical midbrain and limbic regions (Öhman & Mineka, 2001). An alternative hypothesis that was originally proposed by Nairne et al. (2007), too, is that the survival processing effect is due to active elaboration (Kroneisen & Erdfelder, 2011; Röer, Bell & Buchner, 2013).

Negativity

Another proximal mechanism that has been studied is negativity. Could it be that the superior retention of information attained by survival processing could be explained by the negativity that plays a part in survival? By negativity in survival, it is meant that it makes you more aware of mortality since death is diametrically oppositional to life. Röer et al. (2013) studied the effects of emotion on memory, and more exactly they focused on the negativity and mortality salience that may play a part. They included a scenario that described a hopeless situation; a scenario where you are supposed to picture yourself out in space with a dwindling supply of oxygen and the only solution to avoid an agonizing death is to commit suicide. Participants generally rated this scenario more negatively than the other ones included, but a small processing advantage still remained in comparison to the control scenarios. The survival advantage was, however, greater when thinking about survival rather than thinking about death. The survival advantage was found for concrete nouns, but not for abstract. This find is consistent with the assumption that survival instructions in these studies may encourage participants to think about the many uses of a concrete item, and thereby using elaborate encoding. Richness of encoding might be, as mentioned earlier, a prominent proximate mechanism for survival processing.

Negativity and mortality salience is not considered to be a satisfactory explanation for the advantage in retention. It must instead be the thought about the continuation of life and survival that is responsible. In line with this proposition, Röer et al. (2013) presents findings from other studies where evolutionarily inspired hypotheses such as mating, foraging for food, threat avoidance and reciprocal altruism gave a great advantage in retention. Even though scenarios connected to suicide and negativity yielded higher retention than the control scenarios due to the salience of negative stimuli, Röer et al. (2013) still argue that this is because of the elaborate encoding of the information that follows.

Future Planning

Nairne (2010) argues that the majority of researchers in the field of memory focus on understanding specific retrieval environments, more perspectives oriented towards functionality do exist. An idea presented by Schacter and Addis (2007), and Szpunar and McDermott (2008) argues that our memory systems are fundamentally prospective, i.e. oriented towards the future rather than the past (Nairne, 2010, p. 16). From the perspective of natural selection, this idea seems to be in line with the hypothesis of survival advantage. When one merge the past with the present and future, planning for survival must yield a survival advantage.

The main idea behind episodic future thought is something called adaptive simulation (Atance & O'Neill, 2001). This entails that people possess the ability to imagine, and even pre-experience, certain events that could happen in the future which make them able to cope more effectively with future events. This is not connected to the term "pre-cognition" which is something entirely different. People use this ability often, both in a positive and negative manner. We can work ourselves up which can affect us negatively where we get nervous or lose faith in ourselves. This can happen before a job-interview, a competition or a presentation. It could also be used to help us prepare before doing something by analysing the outcomes or things that may happen during. A soccer player may be able to imagine a ball's trajectory when trying to score a goal and thus making the player able to plan for his/her shot.

Survival-processing focuses on the future due to people's propensity to think about scenarios that has never occurred to them in real life as to take place in the future. Planning has been studied by several researchers, but advantage in planning processing is only found to be significant when planning for survival rather than planning for a vacation or moving (Nairne et al., 2007). When participants in a study are asked to plan for survival, one can see that they are simulating the scenario in their mind as found by studies of richness of encoding and future episodic memory. Seamon et al. (2012) has also argued that there is little advantage to only remembering the past, but there is more advantage to be able to remember the past in order to plan for the future.

Thesis

It seems that all research presented here converges toward an advantage in recall when information is processed with survival- and fitness-relevance in mind. The find by Soderstrom and McCabe (2011) that purports a recall advantage without a connection to our ancestral environments as suggested by the ancestral environment hypothesis seems to falsify this. The fact that a survival scenario presenting fictitious creatures such as zombies as the main threat might entail that threats presented originally by popular fictional film and literature may play a role in our threat avoidance systems. Nairne (2010) mentions that it is hard to find generalizable, universal adaptations. Since adaptations could be context independent, all humans may not have all the same adaptations if our memory adaptations could diverge. If the recall advantage in the

zombie-scenario is due to threat avoidance induced by media-related stimuli, then it may be that other media inspired survival-scenarios might yield the same advantage in recall.
The purpose of this study was to investigate if a scenario based on film and fiction could yield an advantage in memory recall much like the zombie scenario tested by Soderstrom & McCabe (2011) in comparison to the ancestral environment hypothesis. The "Meteor Strike" scenario used in this case was based on the apocalyptic genre of film, where natural disasters play a big part of ending life on earth as we know it.

Method

Participants

The participants were not a targeted group, but anyone who wanted to participate in the study. A sample of convenience through a snowball effect using social media such as Facebook, family and friends. Eighty-nine participants entered, only 71 completed the experiment and are a part of the analysis. The mean age of the participants was ca 27 years but with a large spread (M = 26.52; SD = 9.44; spread 19 - 72). No question regarding gender, only age and country of origin. The country of origin was enquired after due to the interest in seeing how wide my study would spread. One issue that came up due to faulty randomization in the software used was that participants were not equally distributed in the conditions. It also had to do with a large portion of participants not completing the task.

Procedure

The study was designed with the help of Oskar Blakstad, who is a Norwegian psychologist managing the website *Explorable.com*. This is a site designed for teaching psychology and statistics, but also to do online studies instead of using labs. An experiment was designed by me based on experiments made by Nairne et al. (2007; 2008; 2010). Once the material was done, a link with the web address to the experiment was forwarded through social media and personal connections. The experiment took approximately 10 minutes (N = 70; M = 9.83; SD = 5.10) to finish. One result was excluded to the extreme length of time spent to finish the assignment (1:28:30).

The participants had to agree to the terms and conditions before moving on to the next part. The second part consisted of a description of a scenario that the participant should imagine being a part of. They were also instructed that the experiment would have them rate 34 words depending on how relevant they were to their scenario (see Appendix 1). A participant could be assigned one out of four possible scenarios which made it a manipulated between-subjects study, followed by a practice round where they rated two words in order to be introduced to the concept. The four scenarios that a participant could be assigned to was a pleasantness scenario (N = 13), a grasslands scenario (N = 19), a zombie scenario (N = 13), and a meteor strike scenario (N = 26). As I mentioned earlier, there is a discrepancy in the division of participants into conditions. This was due to lack of participants actually completing the experiments, and the lack of equal randomization.

The third part consisted of the rating of the 34 nouns that is part of the analysis. These nouns where taken directly from the words used by Nairne et al. (2007), which in turn were based on the Battig and Montague norms (Dunlosky, Rawson & Van Overschelde, 2004). The rating scale was also based on Nairne et al's. (2007), where a 1 – 5 scale was used, where 1 = totally irrelevant to 5 = extremely significant. A time limit of ten seconds was assigned to the rating of each word. After the rating was completed, the participant was asked to rate their emotional excitement at the moment, which was also rated on a scale ranging from 1 – 5. This, together with demographical questions, acted as a manipulative check. Emotional excitement has not

been supported in previous research as a causing factor in recall, but it is nonetheless useful. The final part of the experiment took place directly after the participants had answered the demographical information and consisted of a free recall task. Here, the participants had an unlimited amount of time to recall as many words as possible from the rating section of the experiment. The participants could not go back in the experiment in order to copy the words rated in the free recall section.

Ethics
In a paragraph in the start of the experiment, the participants had to agree to information from me that included their right to withdraw at any time during the experiment, that their results would be treated in concordance with anonymity. The participant was also offered to have the finished paper sent to them in order to take part in the results.

Materials and design
The experiment consisted of four parts (the final "Thank you"-page excluded). The first part introduced the study and informed the participant of his/her rights concerning withdrawal and handling of personal information. The first page of the experiment can be found in Appendix 2. The design is based on Nairne et al's. (2007) and Soderstrom and McCabe's (2011) studies on adaptive memory. They used "Pleasantness" as a control scenario, and used "Grasslands", "Moving" and "Zombies" as experimental scenarios. The "Meteor Strike" scenario was added to the replication of the design of the studies mentioned above.

In this paragraph, a description of each scenario as presented to the participants will be given:

Pleasantness:
In this task, we will show you a list of words, and we would like you to rate the pleasantness of each word. Some of the words may be pleasant and other may not - it is up to you to decide.
1= extremely unpleasant and 5= extremely pleasant.

Grasslands:
In this task we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this survival situation. Some of the words may be relevant and other may not—it's up to you to decide.

Zombies:
In this task we would like you to imagine that you are a survivor of a zombie apocalypse, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from zombies. 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 survival situation. Some of the words may be relevant and other may not—it's up to you to decide.

Meteor Strike:
In this task we would like you to imagine that you are a survivor of a meteor strike to earth, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from looters. 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 survival situation. Some of the words may be relevant and other may not—it's up to you to decide.

Results

The significance levels for all of the statistical comparisons was set at $p < .05$. Participants had little to no difficulty providing relevant ratings for the individual stimuli within the allotted time. Participants provided ratings for almost 98 percent of the presented items, and the number of unrated words (no response within 10 s) did not differ significantly between groups.

The data that is of main interest in this study is the recall level for the different conditions in order to determine if the processing scenarios enhances retention. The means of correctly recalled words for each condition was calculated and compared with a one-way ANOVA test in order to see if a main effect of conditions could be found. An overall analysis on the recall data for every group did however not reveal a significant effect of condition, $F(3, 67) = 1{,}047$, $MSE = .057$, partial $\eta^2 = .047$. As can be seen in the left panel of Figure 1, the "Grasslands" condition yielded the highest recall rate, even though the "Zombies" condition followed closely behind. An ANOVA was also performed on ratings, but this model was not significant either, $F(3, 67) = .585$, MSE = .054, partial $\eta^2 = .047$. An interesting aspect of the results is that survival in the Grasslands had the lowest ratings for survival-usage but still yielded the highest correct recall rate. One suggestion is that it is easier to rate items for their pleasantness, rather than for their survival-relevance, which concords with the results for response time found by them as

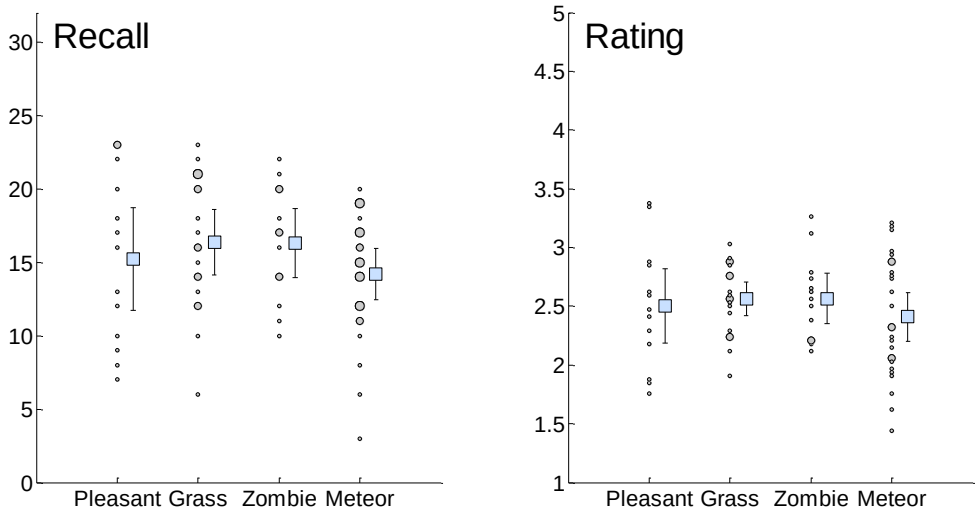

Figure 1. Mean recall (number of words), and average rating sorted by condition. Error bars show 95% confidence intervals. The size of circles is proportional to frequency.

Group	Group	Mean Difference	Std. Error	Sig.
Pleasantness	Grasslands	-1,1377	1,65794	1,000
Grasslands	Zombies	,0607	1,65794	1,000
Zombies	Meteor Strike	2,1154	1,56464	1,000
Meteor Strike	Pleasantness	-1,0385	1,56464	1,000
Pleasantness	Zombies	-1,0769	1,80670	1,000
Grasslands	Meteor Strike	2,1761	1,39022	,733

Table 1. Bonferroni correction analysis of multiple comparisons.

well. In this study, the response time for each individual word was not obtained during the experiment, which only allows for analysing the time it took to finish the experiment for each participant. The problem with this is that it also includes the section for free recall, which was not time-limited. A post hoc Bonferroni correction test was also performed on the data in order to correct p-values and to look for specific effects between groups in the data. As can be seen in Table 1, no significant effects were found.

Discussion

In conclusion, the results from this study did not concord with temporary research in the field. This may be due to the low and uneven amount of participants in each condition. The results that were expected did not show in the analysis of the data. However, some general trends in the data could be compared to the results yielded by other studies by e.g. Nairne et al. (2007) and Soderstrom and McCabe (2011). Since the model used here was not significant, the discussion will have to treat the trends that were found.

The thesis that was explored in this study was "to investigate if a scenario based on film and fiction could yield an advantage in memory recall much like the zombie scenario tested by Soderstrom and McCabe (2011)". This was not supported by the collected data, which could indicate that the exposure of fictional survival scenarios in media is not the reason to why retention increases after processing information. The idea behind my thesis was that since retention in the "Zombies" scenario was even greater than retention yielded by the "Grasslands" scenario as presented by Soderstrom and McCabe (2011), it could be due to salience of the stimuli created by popularity of media related to fictional threats. This could entail that exposure to such survival scenarios in film and on TV could prime people's frame of reference, and in turn make them more used to thinking about surviving in such.

An unexpected result was that the Grasslands scenario yielded the highest recall rate, which contradicts Soderstrom and McCabe (2011). The recall rate was not significantly higher, but still higher. One factor that differed between this study and the study done by McCabe and Soderstrom (2011) is that they specified zombies as a threat in two different scenarios: city and grasslands. The best recall results were yielded by the combination zombies-grasslands. It might be that zombies are displaced in the context, since most media juxtapose zombies in a city.

Soderstrom and McCabes (2011) results might also have to do with the von Restorff effect (von Restorff, 1933), where zombies in a grassland scenario seems more absurd and therefore increases its salience. In this study, neither the scenario containing zombies nor the meteor strike contained a description of the imagined whereabouts of the participant. Most scenarios described in other studies include a specific location that the threat is presented in. I did not describe where the threatening situation was taking place, and that could have made it more difficult for participants to imagine the situation properly.

Another unexpected result was that the meteor strike scenario, which is novel to the field, yielded the lowest recall. Compared to the pleasantness scenario, the meteor strike scenario was expected to yield a higher recall rate, but the data did not support this thesis. Due to the lack of environment descriptions might have prevented participants to elaborate during the encoding process. The richness of encoding mechanism mentioned in the rating stage may therefore not have been playing a significant part. Richness of encoding seems to be an important proximate mechanism that facilitates the recall of words. By omitting the environment from the scenario described might have hindered participants from elaborating. It might also be the case that the meteor strike did not induce elaborate coding in the participants. The meteor strike scenario is

not as popular in film that zombies are, which has gotten an upswing in later years. Since zombies are animate and can be a threat on the same level as humans, it can seem like a real threat in opposition to a big meteor striking the planet. It may also be hard to imagine how a meteor strike plays out.

The pleasantness scenario yielded a lower recall rate than the grasslands and zombies scenario, this is in line with previous research (Nairne et al., 2007; 2008; 2010; Soderstrom & McCabe 2011). This result concords with Nairne et al's. (2007) study, where they also found that the condition for pleasantness had the highest ratings, yet low recall yield. Rating for pleasantness is a memory mechanism that has been proven to yield increased recall. Processing in a scenario based in the grasslands increases the recall rate, and processing in a zombie scenario increases the recall rate to a greater extent. Soderstrom and McCabe (2011) speculated that it might have to do with the activation of death and disgust systems. The meteor scenario does not activate death and disgust systems in the direct manner that zombies may do due to the appearance of these creatures. A meteor strike can cause gruesome damage to both humans and the environment that surrounds them, but it may take more elaboration to bring those images to mind. A functionalist perspective seems to have bearing on the results achieved by this study. The threat of zombies and the gathering of supplies and water in the grasslands demands that participants think about the function of objects that can help them survive. Even if a cataclysmic event such as a meteor strike is threatening to the survival of the human species, it may be difficult for participants to imagine how the items presented in the rating section of the experiment could be used functionally in such a scenario. It seems to be easier to think functionally about objects in a survival scenario that allows participants to actually utilize them.

This study has some deficiencies that may have affected the results. The main problem is the distribution participants that was unequal across the conditions. The demography differed to a large extent, which may have affected the results as well. A replication of this study with better conditions could be appropriate in order to investigate if there is any significant effect at all. Earlier research mentioned in this study found significant effects in recall between the pleasantness-, grasslands- and zombie-scenarios.

Another aspect that would be prudent to research is if the zombie-scenario yields better recall, as found by Soderstrom and McCabe (2011), because of the activation of death and disgust-systems; could other fictional creatures induce the same recall advantage? By comparing scenarios involving creatures inducing feelings of disgust, one may find out if that could be a proximal mechanism behind the supposed advantage in survival-related processing. It could also be beneficial to investigate if other survival scenarios presented in popular films and games could increase recall.

Conclusion

This study did not provide a statistical significance for the model based on the different conditions. The data was carefully interpreted based on the statistics that were obtained, but no real conclusion has been reached. Threat is not a sufficient factor to determine if greater recall will be attained as in concordance with results found by Röer et al. (2013). The results also show that survival-related scenarios presented in popular media does not satisfactorily explain why the threat to survival in the form of zombies. The thesis that survival-related scenarios presented by film and series yield greater recall was not supported. Further research could replicate the study partially in order to correct the inadequate participation in this study to check if a more accurate analysis can be performed. A scenario that differs from a meteor strike could

be used that still acts as a threatening natural disaster, such as a tsunami, earthquake or flooding. This would not be directly related to the hypothesis presented here that was based on survival-fitness related to popular film and series, but it could be interesting to investigate if scenarios that present an opportunity for more elaborate encoding could yield greater recall.

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Appendix 1 – Stimuli rated by participants

Wallpaper	Flute
Stone	Snow
Truck	Door
Diesel	Broccoli
Mountain	Bear
Pepper	Cathedral
Book	Screwdriver
Carbon	Car
Juice	Sword
Shoes	Apartment
Finger	Soccer
Aunt	Silk
Chair	Teacher
Catfish	Pan
Silver	Sock
Orange	Eagle
Whiskey	Emerald

Appendix 2 – Instructions for participants in the beginning of the experiment

Information Processing

Instructions

Dear participant,

In this study, you will be given a description of a scenario. After reading this carefully, you will be shown several words that you are to rate in concordance with how relevant this item is in the scenario you read at the beginning. You will have the alternative of rating these words from 1-5, where 1 = totally irrelevant and 5 = extremely relevant. You will have only 10 seconds to rate each word.

Click "Next Page" in order to proceed after checking the consent form.

Consent Form

Please read this information carefully before consenting to participate in this research. Study subject: This study investigates the processing of information in certain scenarios. Time required: This study will approximately take 5-15 minutes to complete. You can choose to withdraw from this study at any time during this experiment. Confidentiality: Your responses will not be matched to your identity. Your participation in this study is confidential. *

☐ I agree