

Does the thought of death contribute to the memory benefit of encoding with a survival scenario?

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Four studies tested whether the thought of death contributes to the survival processing advantage found in memory tests (i.e., the survival effect). In the first study, we replicated the “Dying To Remember” (DTR) effect identified by Burns and colleagues whereby activation of death thoughts led to better retention than an aversive control situation. In Study 2, we compared an ancestral survival scenario, a modern survival scenario and a “life-after-death” scenario. The modern survival scenario and the dying scenario led to higher levels of recall than the ancestral scenario. In Study 3, we used a more salient death-thought scenario in which people imagine themselves on death row. Results showed that the “death-row” scenario yielded a level of recall similar to that of the ancestral survival condition. We also collected ratings of death-related thoughts (Studies 3 and 4) and of survival-related and planning thoughts (Study 4). The ratings indicated that death-related thoughts were induced more by the dying scenarios than by the survival scenarios, whereas the reverse was observed for both survival-related and planning thoughts. The findings are discussed in the light of two contrasting views of the influence of mortality salience in the survival effect.

Keywords: Adaptive memory; Death; Mortality salience; Survival effect; Evolutionary psychology.

Adaptive memory is an important issue in memory research. In a series of recent studies, Nairne and colleagues (e.g., Nairne & Pandeirada, 2008a, 2008b, 2010a; Nairne, Pandeirada, Gregory, & Van Arsdall, 2009; Nairne, Pandeirada, & Thompson, 2008; Nairne, Thompson, & Pandeirada, 2007) provided evidence for the hypothesis that our current memory systems have evolved through a process of natural selection, with the result that footprints of ancestral selection pressures are still operant in healthy memory functioning. In a

seminal study, Nairne et al. (2007) showed that encoding lists of unrelated words within the framework of a survival scenario led to better memory performance (in unexpected free-recall tests) than other well-known (deep) encoding strategies such as self-encoding, pleasantness or imagery ratings; this has been called the survival effect (see Nairne & Pandeirada, 2008b for an overview). More precisely, the participants in Nairne et al.’s (2007) study had to imagine they were stranded in the grasslands of a foreign

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country without any survival equipment. During the study phase, they had to rate on a five-point scale whether each of the unrelated words presented in a list was relevant in this survival situation. Importantly, the advantage of the survival scenario has been found when compared to similar scenarios involving schema integration, such as moving to a foreign country.

Although the proximate mechanisms underlying the survival memory advantage are still unknown, there have been some attempts to explain this phenomenon. Nairne et al. (2007) accounted for the mnemonic advantage of the survival condition within an evolutionary perspective, whereby human memory evolved, subject to the natural criteria of differential survival and reproduction. As a result, our ability to remember is probably attuned to solve fitness-related problems, particularly those that were predominant in the ancestral environments in which memory evolved. This view predicts that optimal cognitive performance might sometimes be induced by problems rooted in ancestral conditions, in other words, those present in ancestral environments, rather than by adaptive problems faced more commonly in present-day environments (Nairne & Pandeirada, 2010b). However, certain studies have challenged this view (e.g., Burns, Burns, & Hwang, 2011; Nouchi, 2013), suggesting that the advantage of survival encoding is not underpinned by the special mnemonic properties of survival situations, but is simply the result of basic memory mechanisms (e.g., elaboration, see Nouchi, 2013; item-specific and relational processing, Burns et al., 2011; richness of encoding, Röer, Bell, & Buchner, 2013, but see Nairne, 2014). Burns et al. (2011) put forward the hypothesis that the superiority of the survival scenario could be due (at least in part) to the fact that it promotes both item-specific and relational processing. Accordingly, they used encoding conditions which enhanced either item-specific processing or relational processing only. Their findings showed that survival processing improved memory performance only in cases where either item-specific or relational processing was promoted by the control conditions (see also Burns, Hart, Griffith, & Burns, 2013). Importantly, the memory benefit of survival encoding was no longer observed when the control conditions required both item-specific and relational processing. Thus, the memory advantage of survival scenarios can be accounted for in terms of basic memory mechanisms—such as the elaboration and organisation of information—that are triggered

when processing items for the purposes of survival. In another study, the strong adaptive memory hypothesis championed by Nairne and colleagues was challenged by the finding that a planning scenario (i.e., a future-oriented task in which participants imagine they are planning a camping trip in the forest) led to better memory performance than the survival scenario (Klein, Robertson, & Delton, 2011). Klein et al. (2011) compared different encoding situations that encouraged the processing of stimuli for their relevance for both survival and planning, for planning but not survival, or for survival but not planning. They found that conditions that induced planning processing led to a memory advantage compared to those that induced survival but not planning processing. Thus, the advantage of survival processing in long-term encoding is not always found, or in other words, the survival advantage is operative within certain boundaries (Otgaar et al., 2011). One important issue in this literature is therefore to determine whether the so-called survival effects are not in fact due to factors that are not directly relevant to survival issues (e.g., finding food and water; protection from predators). In the present research, we tested the hypothesis that survival effects are underpinned by the fact that the traditional ancestral survival scenario has the potential to activate thoughts of death. This hypothesis was initially suggested to us by two studies, one by Soderstrom and McCabe (2011) and the other by Hart and Burns (2012); the latter directly assessed the impact of the thought of death on memory performance.

Soderstrom and McCabe (2011) demonstrated that an encoding scenario involving threats from fictitious creatures (i.e., zombies) resulted in better recall performance than a scenario involving ancestral threats (i.e., predators). Although this result is surprising in the light of the original hypothesis of a possible genetically encoded mechanism that is conducive to survival, the idea put forward by the authors (suggested by a reviewer, see their footnote 4 p. 568) that the scenario including zombies led to the activation of thoughts of death is of particular relevance to the present study. In their words: “Perhaps survival scenarios that included zombies led to the activation of ‘death and disgust systems’, making this threat more salient” (p. 568).

Hart and Burns (2012) demonstrated that inducing mortality salience yielded better memory performance on recall tests compared to several control conditions (mundane or aversive, e.g.,

watching TV, experiencing paralysis or dental pain)—an effect thereafter called the “Dying To Remember (DTR) effect”. According to Hart and Burns (2012), activating thoughts of death would engage more relational or elaborative processing, which would account for the superiority of recall under the mortality salience condition. Indeed, the hypothesis that activating thoughts of death (i.e., mortality salience) leads to specific behavioural outcomes in humans, compared to other negative and/or emotional scenarios, derives from a very influential theory—Terror Management Theory (TMT, e.g., Greenberg, Pyszczynsky, & Solomon, 1986; Hayes, Schimel, Arndt, & Faucher, 2010). Very recently, other studies have also examined this issue more critically and reached different conclusions concerning the influence of mortality salience in the survival effect. Since we will return to certain specific aspects of these studies in the General Discussion, we do go now into the details of the studies described below.

Burns and colleagues (Burns, Hart, & Kramer, 2014a; Burns, Hart, Kramer, & Burns, 2014b; Hart & Burns, 2012) claimed to have found supportive evidence for the hypothesis that processing words in relation to death and to survival are related. Indeed, in their earlier work, Hart and Burns (2012) suggested that the two effects may share underlying mechanisms. According to Burns et al. (2014a), if the survival and the DTR effects are underpinned by similar proximate mechanisms, the effects of mortality salience and survival processing on memory performance should be redundant. To test this hypothesis, they designed an experiment in which they manipulated both mortality salience and survival processing. Participants were first given a task in which they had to write about either death or dental pain, and then to rate words according to their pleasantness value or their relevance to the ancestral survival scenario. They found that the mortality salience group had higher recall rates than the dental pain control group following pleasantness rating (a DTR effect). However, the DTR effect was not reliably observed when the words were rated for their survival relevance. This finding was taken as evidence that the processing induced by the mortality salience procedure overlaps with that required by the survival task.

Klein (2014) also compared survival and mortality processing directly. Contrary to the hypothesis of overlapping mechanisms between the survival and DTR effects, Klein (2014) argued conceptually that DTR and survival processing

effects are largely (or totally) independent, in part because of the recency of mortality awareness in hominids. The line of reasoning of Klein (2014) is that if survival processing induces a mortality salient state that mediates the survival processing effect, a dying scenario that precludes the possibility of survival should enhance retention to the same extent as the ancestral survival scenario. In his study, some participants had to imagine they were about to die and had to rate words for their relevance to the circumstances surrounding their death (dying scenario). The dying scenario produced the same level of recall as the pleasantness rating group, but the survival scenario yielded the highest recall. Klein (2014) suggested that the recall advantage associated with survival processing was therefore not due entirely to mortality salience. However, according to Burns et al. (2014a), Klein’s (2014) findings regarding the mortality condition could not be optimally compared to the traditional grasslands condition, because his dying scenario was thought to be less thematic, detailed and concrete than Nairne’s classic survival scenario. Thus, Burns et al. (2014a) directly compared survival processing scenarios with “death processing” scenarios that were closely matched on these dimensions. This time, the dying and survival scenarios produced similar recall levels. They therefore suggested that these findings were in accordance with the possibility of overlapping mechanisms.

Finally, Bell, Röer, and Buchner (2013) compared a grasslands survival situation with a situation in which participants had to imagine that they had decided to commit suicide (e.g., to avoid the agony of choking to death) and rate words for their usefulness in such a situation (Experiment 1). As controls, they included a moving-home scenario and a pleasantness condition. The recall rates were higher in the survival situation than in the other conditions. In the third experiment, the participants were simply asked to judge words (concrete and abstract) for their relevance for either death or survival. For concrete words, the recall rate was higher in the survival than in the death condition. The overall findings were therefore taken as evidence that DTR and survival effects are independent.

The studies reviewed above draw different conclusions about the influence of mortality salience on the survival effect. It therefore remains unclear as to whether or not the mechanisms that underlie the DTR and survival effects overlap. As a result, and as acknowledged by Burns et al.

(2014a), more research on this issue is needed. The goal of our study was therefore to submit to further empirical tests the idea that the memory effects of survival and death thoughts are underpinned by similar mechanisms, and thus that the survival effect in memory is related to the activation of death thoughts. Our general working hypothesis is that if survival processing induces a mortality salient state that mediates the survival processing effects, these should vary as a function of death thought activation. If the ancestral (grasslands) survival scenario activates thoughts of death, and this activation subserves the survival processing advantage, then encoding words in a dying scenario should yield a retention performance similar to that found when encoding words in the ancestral-grasslands scenario. In Klein's (2014) study described above, the dying scenario produced similar recall to the pleasantness rating condition, but the ancestral survival scenario yielded the greatest memory advantage. Klein (2014) suggested that the recall advantage associated with survival processing was therefore not due entirely to mortality salience. The ancestral survival effect has been claimed to be the best encoding procedure compared to other deep encoding procedures (e.g., imaging, self-reference, pleasantness) (Nairne & Pandeirada, 2008b). Importantly, the grasslands scenario has been found to yield a retention advantage superior to that of a modern survival scenario (Nairne & Pandeirada, 2010a; Weinstein, Bugg, & Roediger, 2008 but see Soderstrom & McCabe, 2011). If the hypothesis that mortality salience is related to survival processing is correct, one implication is that the modern survival scenario activates fewer thoughts of death than the ancestral scenario. However, before elaborating further, it is worth remembering that the various studies addressing the question of whether or not survival and death processing have overlapping processes have all taken for granted the reliability of the DTR effect reported by Hart and Burns (2012), whereby awareness of one's mortality is advantageous for memory performance. More precisely, they showed that items encoded after a mortality-salient condition benefited from a retention advantage compared to other aversive or mundane control conditions. However, even though there are an impressive number of studies that have investigated the influence of mortality salience on several behavioural aspects (i.e., mortality salience is a strong hypothesis that derives from the TMT, see General Discussion), to our

knowledge, only the studies by Hart and Burns (2012) and Burns et al. (2014b) have so far demonstrated a beneficial effect of death awareness on memory recall. Since this effect was only observed twice and has not been replicated by an independent research group, and because our line of reasoning is based on it, our first study aimed to replicate Hart and Burns' (2012) finding that activating death thoughts has a genuine influence on long-term retention.

STUDY 1

In this study, the goal was to replicate the DTR effect first demonstrated by Hart and Burns (2012) in their Experiment 3 in which unrelated words were used. In that experiment, they used a mortality salience condition and an aversive control condition involving a dental pain scenario. This type of control condition has typically been used in the TMT (Terror Management Theory) literature to assess the influence of death reminders (e.g., Wisman & Goldenberg, 2005). Their results showed that the number of words recalled after inducing mortality salience was higher than after inducing thoughts of dental pain. We used the same words and procedure as Hart and Burns (2012) in an attempt to replicate their findings as accurately as possible. In order to measure the extent to which death thoughts had been activated, we used an implicit fragment-completion task (as designed by Chatard, Arndt, & Pyszczynski, 2010 in French).

Method

Participants. Thirty-nine students at the University of Bourgogne participated in the study. All participants received course credit for their participation.

Stimuli. The word list was the same as that used by Hart and Burns (2012). The list items were 36 unrelated words.

Procedure. Participants were assigned to one of the two encoding conditions. They were given the following instructions: "Please describe briefly the emotion that the thought of your own death [severe dental pain] arouses in you, as specifically as you can", and "Please describe what you think will happen to you when you physically die [you

are confronted with dental pain]". The mortality salience manipulation (Rosenblatt, Greenberg, Solomon, Pyszczynski, & Lyon, 1989) reliably primes death-related thoughts (Hayes et al., 2010). Next, the participants were instructed to read a list of words and to remember them for a subsequent test. At recall, the participants were told that they had 5 minutes to write down the previously presented words in any order they liked. Finally, they were given a word-completion task (5 words were related to death; 5 were negative words and 12 were neutral words) to test the accessibility of the death concept (see Chatard et al., 2010).

Results

Separate ANOVAs were performed on hit rates and number of correctly completed negative and death-related words in the two conditions. In this and the following experiments, significant differences are at least with $p < .05$.

As illustrated in Figure 1, the recall rate was higher in the mortality salience condition than in the dental pain condition, $F(1, 37) = 14.71$, $\eta_p^2 = .28$.

For the word-completion task, we found that more death-related words were completed under the mortality salience condition ($m = 1.47$, $sd = .84$) than under the dental pain condition ($m = 0.75$, $sd = .55$), $F(1, 37) = 10.21$, $\eta_p^2 = .28$, strongly suggesting that manipulating mortality salience reliably primed death-related thoughts. The difference between the two conditions was not significant ($F < 1$) for the completion of negative words (mortality salience: $m = 1.05$, $sd = .91$; dental pain: $m = 1.00$, $sd = .79$).

Discussion of Study 1

The aim of this study was to replicate the findings of Burns and colleagues (Burns et al., 2014b; Hart & Burns, 2012) that inducing death thoughts improves memory compared to control (aversive or neutral) conditions. This seemed essential as their finding initiated recent discussions about whether similar mechanisms underlie the processing of words pertaining to survival and death. Our results do indeed support their finding. We found that people who were reminded of their future death and then processed unrelated words had a better recall rate in a subsequent memory test than people who were instructed to think about an aversive event, namely dental pain. Thus, it appears that items encoded subsequent to a mortality-salient state have a retention advantage. The observation that death awareness plays a role in memory functioning is in line with the TMT which postulates that many human behaviours function as a protection against thoughts of our inevitable death (e.g., Pyszczynski, Greenberg, & Solomon, 1999). It is important to stress here that the effect of mortality salience on memory cannot be reductively explained by affect or arousal, both of which are widely known to influence memory (e.g., Dewhurst & Parry, 2000; Kensinger & Corkin, 2003; Ochsner, 2000; Sharot & Yonelinas, 2008), since it has repeatedly been found in the TMT literature that writing briefly about one's own death does not typically have an impact on self-reported affects.

Having replicated the DTR effect, our next aim was to test the general hypothesis that survival processing induces a mortality salient state that mediates the survival processing effects. If the

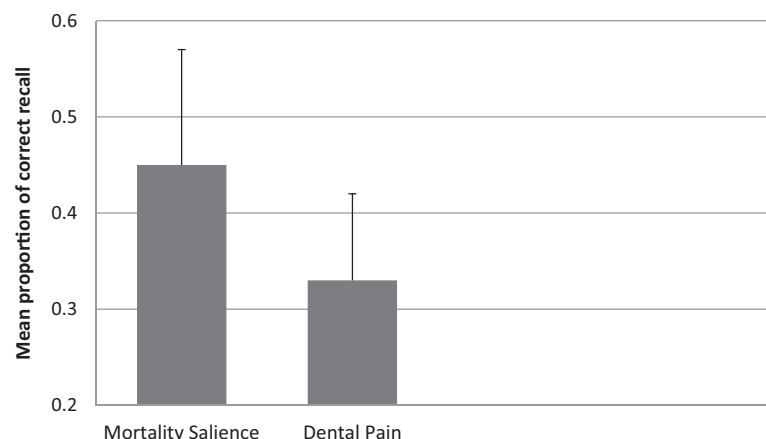


Figure 1. Mean proportions and standard deviations of correct recall as a function of encoding conditions in Study 1.

ancestral (grasslands) survival scenario activates thoughts of death which subserve the survival processing advantage, encoding words in a dying scenario should yield a retention performance similar to that found when encoding words in the ancestral-grasslands scenario. In the second study reported below, we tested what we will refer to as the “life-after-death” scenario against two different survival scenarios (ancestral and modern) and a standard deep-processing control condition, namely pleasantness. We took into consideration Burns et al. (2014a) criticism of Klein’s (2014) dying scenario by choosing a thematic, detailed and concrete dying condition. In the life-after-death scenario, the participants had to imagine that they had been informed that they were about to die having just been told that there is life after death. Their task was to rate words according to whether they would like to find the same objects, animals, people, etc. in the afterworld (care was taken not to use the word “paradise”, see the Procedure section). The hypothesis of functional overlap between the DTR and survival effects predicts that the life-after-death scenario should yield a retention advantage (compared to a deep encoding condition such as pleasantness) similar to the ancestral survival scenario. By contrast, if the effects are relatively independent, ancestral survival processing should yield a recall advantage over both the dying and the modern survival scenarios.

STUDY 2

Method

Participants. Ninety-two students at the University of Clermont-Ferrand participated in the study. All participants received course credit for their participation.

Stimuli. The word list was the same as that used by Nairne et al. (2007, Experiments 2–4), translated into French. Thirty-two concrete nouns were presented on a computer at a rate of 5 seconds per word. A between-subjects design was used; the same words were presented in the same order for the four rating scenarios ($n = 23$ in each group).

Procedure. Participants were assigned to one of the four encoding conditions and were given the following instructions:

Survival condition: In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land, without any survival equipment. In the coming months, you will have to find stable supplies of food and water and protect yourself from predators. We will present you with a list of words and want you to rate the relevance of each word in the survival situation. Some of the words may be relevant and others not, it’s up to you to decide. You must use a rating scale of 1 (totally irrelevant) to 5 (extremely relevant).

Life after death: In this task, we would like you to imagine that you are about to die and that you have just been informed that another world exists after death. Before going to this world, you are told to imagine it and think about the animals, objects, people, etc. you would like to see there just as in the world you know. We will present you with a list of words and would like you to rate the relevance of each word depending on whether or not you would like to find it in the after-death world. Some of the words may be relevant and others not, it’s up to you to decide. You must use a rating scale of 1 (totally irrelevant) to 5 (extremely relevant).

World War III: In this task, we would like you to imagine that you are living in a warring nation in World War III and that your life is seriously threatened. Over the coming months, you have to find stable supplies of food and water and protect yourself from enemy troops. We will present you with a list of words and want you to rate the relevance of each word in the war survival situation. Some of the words may be relevant and others not, it’s up to you to decide. You must use a rating scale of 1 (totally irrelevant) to 5 (extremely relevant).

Pleasantness: In this task, you will be presented with a list of words and we would like to you rate the pleasantness of each word. Some of them may be pleasant and others not, it’s up to you to decide. You must use a rating scale of 1 (extremely unpleasant) to 5 (extremely pleasant).

The test phase was administered after a 5-minute retention interval. During this interval, the participants performed a digit-recall task. At recall, the

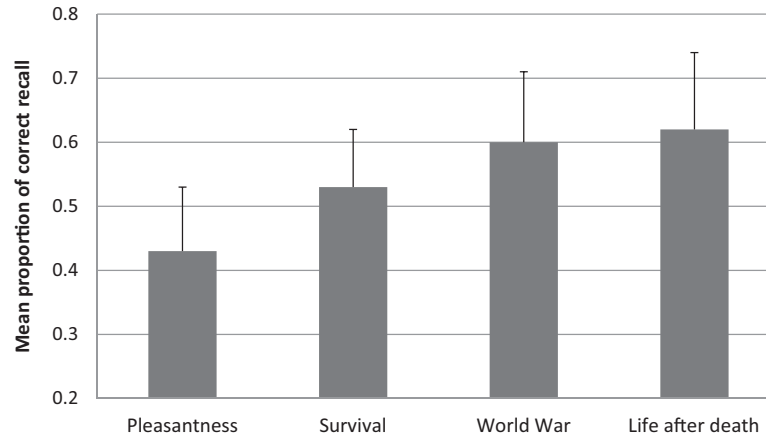


Figure 2. Mean proportions and standard deviations of correct recall as a function of encoding conditions in Study 2.

participants were told that they had 5 minutes to write down the previously presented words in any order they liked.

Results

The means and standard deviations for the recall rates in the different encoding conditions are presented in Figure 2. The mean rating scores in the four conditions are presented in Table 1.

Separate ANOVAs were performed on these different measures.

A reliable effect of Type of encoding factor was found on the recall rates, $F(3, 77) = 13.33$, $\eta_p^2 = .34$. Newman-Keuls tests indicated that the pleasantness condition differed reliably from the other three encoding conditions. Furthermore, the survival encoding condition yielded reliably lower recall than the life-after-death and World-War-III scenarios.

For rating scores (see Table 1), a reliable main effect of the different conditions of encoding was

TABLE 1
Mean ratings as a function of encoding conditions for Studies 2, 3 and 4. Standard deviations are provided in parentheses

<i>Study 2</i>				
	<i>Pleasantness</i>	<i>Survival</i>	<i>World War III</i>	<i>Life after death</i>
Relevance	3.01 (0.23)	2.83 (0.39)	2.62 (0.25)	2.97 (4.80)
<i>Study 3</i>				
	<i>Death-row</i>	<i>Survival</i>	<i>World War III</i>	<i>Life after death</i>
Relevance	1.97 (0.51)	2.45 (0.43)	2.48 (0.42)	3.21 (0.47)
<i>Ratings on scenarios</i>				
Emotion	2.6 (1.13)	2.32 (1.05)	2.60 (0.89)	2.64 (1.11)
Valence	1.48 (1.09)	1.03 (1.38)	1.48 (1.43)	1.37 (1.42)
Interest	4.06 (0.63)	4.06 (0.57)	4.10 (0.76)	4.19 (0.65)
Death	3.33 (1.24)	1.64 (0.98)	3.17 (1.29)	2.35 (1.28)
<i>Study 4</i>				
	<i>Death-row</i>	<i>Survival</i>	<i>World War III</i>	<i>Life after death</i>
Relevance	1.63 (0.33)	2.17 (0.33)	2.29 (0.31)	2.05 (0.44)
<i>Ratings on scenarios</i>				
Own-death	2.24 (0.99)	1.39 (0.50)	1.76 (0.77)	2.43 (1.03)
Other-death	1.86 (1.01)	1.24 (0.54)	2.00 (0.89)	1.90 (1.04)
Own-survival	1.90 (0.77)	2.62 (0.86)	2.95 (0.74)	1.81 (0.81)
Other-survival	1.71 (0.90)	1.71 (0.90)	2.43 (1.12)	1.86 (0.91)
Imagery	2.76 (0.83)	3.24 (0.94)	3.47 (0.68)	2.90 (0.99)
Familiarity	2.05 (0.67)	2.05 (1.07)	2.71 (0.78)	1.90 (0.90)
Planning	2.31 (1.17)	3.19 (0.68)	3.19 (0.75)	2.00 (1.05)

found, $F(3, 78) = 5.47$, $\eta_p^2 = .17$, Newman-Keuls tests showing that all the conditions differed from the World-War-III scenario, which was rated reliably lower than the other encoding conditions.

Discussion of Study 2

In Study 2, we tested the hypothesis of functional overlap between the DTR and survival effects. The main findings can be easily summarised. As anticipated, the pleasantness condition led to the lowest recall performance compared to the other three encoding conditions. In line with previous findings (Nairne & Pandeirada, 2008a, 2008b, 2010a; Nairne et al., 2007, 2008, 2009), we found that survival processing led to better recall than pleasantness processing. Recall performance was lower under the survival condition than under the World-War-III and life-after-death conditions. Finally, the life-after-death and World-War-III encoding conditions yielded similar levels of recall. This latter finding could be taken to suggest that the modern (World-War-III) survival scenario and the (after-death) dying scenario rely on similar mechanisms. Following Hart and Burns's (2012) mortality salience hypothesis, it is conceivable that the World-War-III and life-after-death conditions produce greater recall than survival processing, because they elicit more thoughts of death.

First of all, it is possible that thinking about death, and more particularly the fear associated with our inevitable death (namely the existential terror of our finitude, Greenberg, Solomon, & Pyszczynski, 1997; Solomon, Greenberg, & Pyszczynski, 1991), enhances the affective component by increasing the emotional valence of words. In line with this suggestion, several studies have demonstrated that emotionally arousing items are remembered more vividly than neutral ones (Kensinger & Corkin, 2003; Ochsner, 2000; Sharot & Yonelinas, 2008). The emotional content could lead to additional distinctiveness, for instance in the form of personal relevance or a physical response that does not occur with neutral stimuli (Gutchess, Kensinger, Yoon, & Schacter, 2007; LeDoux, 2000). However, the words used in the study were not specifically valenced. Moreover, and importantly, the TMT literature has repeatedly shown that the activation of thoughts of death is not associated with emotional and affective outcomes as measured for instance by the PANAS scales (Watson, Clark, & Tellegen, 1988).

Secondly, it is possible that the mortality scenario promotes greater self-referential

processing (clear evidence for this phenomenon has been found by social psychologists, e.g., Hansen, Winzeler, & Topolinski, 2010). In effect, in the life-after-death scenario, participants had to judge the relevance of words with reference to their past lives in order to determine whether they wanted to find the objects in the after-world. A large body of research has shown that building links between targets to be remembered and information pertaining to the self enhances memory performance (Conway & Dewhurst, 1995; Conway, Dewhurst, Pearson, & Sapute, 2001; Van den Bos, Cunningham, Conway, & Turk, 2010). This kind of encoding allows personal cues to be encoded, thereby associating a wealth of sensory features with the target. It serves to enrich the studied events and usually results in their recall. In addition, it makes it possible to increase the likelihood of remembering not only a personal experience, but also the phenomenological details of the corresponding event. Since the participants had to imagine what items from the current world they would like to find in the after-death world, we may suppose that they were led to re-live an event from their own lives, and thus that they encoded many autobiographical details associated with the words presented at study. Nevertheless, it is worth remembering that in Nairne et al.'s (2007) study, survival encoding was directly compared to self-reference encoding. The authors found that survival outperformed self-reference. Thus, it is unlikely that self-reference processing elicited by the life-after-death scenario accounted for the findings of Study 2.

Another important finding of Study 2 worth mentioning is that the World-War-III (modern survival) scenario improved long-term retention more than the ancestral survival scenario. This is particularly intriguing in the light of the findings reported by both Weinstein et al. (2008) and Nairne and Pandeirada (2010a), who compared a modern survival scenario (survival in a city) with the ancestral environment scenario (the grasslands). The authors found that the recall performance was better after the words had been processed under an ancestral environment condition than under a modern environment condition. This important finding was taken to support the idea that our memory system may be tuned to ancestral priorities. The discrepancy between our findings and those of Weinstein et al. (2008) and Nairne and Pandeirada (2010a) could be due to differences in the details of the survival situations. In Nairne and Pandeirada's (2010a) study, the modern survival situation involved a dangerous

attacker who had been seen in the area (Experiment 1) or a dangerous infection whose cure required the discovery of suitable antibiotics (Experiment 2). However, no details were provided concerning the nature of the attacker or the type of infection. In our World-War-III scenario, some details were provided about the cause of possible death. We postulate that providing details about the scenario enhances the organisation and elaboration processes, and thus leads to better memory retention. Moreover, it is also possible that our modern survival scenario was more likely to evoke certain specific emotions and images, because participants are frequently confronted with war-related emotions and images via the media (TV, films, books or memories recounted by people (e. g., grandparents) who have experienced war). Thus, these images and/or stories might lead to a more highly elaborated encoding of the words including episodic details that could facilitate memory recall (Bugaiska et al., 2007; Clarys, Bugaiska, Tapia, & Baudouin, 2009). We realise that this finding must be replicated before developing further the possible differences between our modern survival scenario and that of Weinstein et al. (2008) and Nairne and Pandeirada (2010a). Thus, in Study 3, we again included this condition to compare it with the ancestral survival condition.

More importantly, there are several shortcomings in our Study 2 which seriously limit the above interpretations. In effect, the degrees to which the different scenarios varied in emotion, valence, interest and thoughts of death were not directly assessed. These dimensions were therefore measured in Study 3. Moreover, the life-after-death scenario could be criticised on the grounds that the thought of death was not really frightening since the scenario explicitly mentioned that there was literal immortality (= physical life) after death. Thus, thoughts of death were certainly activated but were not existentially terrifying. In the TMT literature, there is evidence that inducing ideas of symbolic or literal immortality after death can moderate certain effects (e.g., worldview defence) that are usually observed when such thoughts are not induced (e.g., Dechesne et al., 2003). In Study 3, we included a death scenario in which participants were asked to imagine their own death without any hope of life after physical death, i.e., inevitable death. Here also, given Burns et al. (2014a) criticism that the “inevitable death” scenario used by Klein (2014) was framed in a rather abstract way, we designed a scenario involving the contemplation of personal death that was thematic,

detailed and concrete. In addition, following Soderstrom and McCabe’s (2011) suggestion, we collected ratings for emotion, valence, interest and activation of thoughts of death that could account for the effects of the different scenarios.

STUDY 3

Method

Participants. Participants in the study were 122 students at the University of Bourgogne. All participants received course credit for their participation.

Stimuli. The word list was the same as that used for Study 2.

Procedure. Participants were assigned to one of the four encoding conditions and were asked to rate the words. Three of the four conditions used in the present study were exactly the same as in Study 1. Thus, for ancestral survival, life-after-death and World-War-III conditions, the instructions were the same as in Study 1. The new encoding condition was “death-row”, and for this condition, participants were given the following instructions:

In this task, we would like you to imagine that YOU are on death row in a prison in Texas. Your request for clemency has been rejected. You will thus be executed in two days; YOUR death is imminent. You will leave this world. However, before dying, there are probably a number of things in life that you will be sorry to leave. We will present you with a list of words and you must rate the extent to which you think that you will be sorry to leave each item.

The test phase was administered following a five-minute retention interval in which the participants performed a digit-recall task. At recall, the participants were told that they had 5 minutes to write down the previously presented words on a sheet of paper in any order they liked. In addition, they were again presented with the scenario on which their ratings were based. Below the scenario, they were asked to make four final ratings, one based on the interest generated (1 = not interesting to 5 = very interesting), one on emotion generated (1 = no emotion to 5 = strong emotion), one on emotional valence (-4 = extremely negative to 4

= extremely positive), and the last one on the activation of thoughts of death (1 = I did not think about death at all, to 5 = I thought about death very strongly). The order was counterbalanced.

Results

The means and standard deviations for ratings and dimension ratings corresponding to the four encoding conditions are provided in Table 1. Separate ANOVAs were performed on each measure.

Figure 3 illustrates that the type of scenario significantly affected recall, $F(3, 118) = 3.57$, $\eta_p^2 = .08$, Newmans-Keuls comparisons indicating that “death-row” differed reliably from the life-after-death and World-War-III conditions but not from the ancestral survival condition. For the rating scores performed during the encoding task, a reliable main effect of type of encoding was found, $F(3, 118) = 37.78$, $\eta_p^2 = .49$. Newmans-Keuls tests indicated that all the conditions differed except the World-War-III and ancestral survival conditions.

We conducted separate ANOVAs on the ratings of interest, emotion, valence and thoughts of death to investigate the possible effects of the different scenarios. No reliable main effects of the Type of encoding factor was found for interest, emotion or valence, $F_s < 1$, except death thoughts, $F(1, 118) = 12.84$, $\eta_p^2 = .34$. On this latter measure, Newman-Keuls tests showed that the ratings were reliably higher for the “death-row” encoding condition than the ancestral survival, life-after-death and World-War-III conditions (see Table 1). The only difference that was not

reliable was between “death-row” and World-War-III conditions.

Discussion of Study 3

Study 3 was designed to test further the effect of thoughts of death on memory recall and more precisely the hypothesis of functional overlap between the DTR and the ancestral survival effects. Unlike Study 2, in which the death scenario provided hope for literal immortality and could therefore have limited the genuine influence of thoughts of death per se (e.g., Dechesne et al., 2003), Study 3 included a scenario in which literal or symbolic immortality was not made salient. The “death-row” scenario involved a concrete situation in which people had to imagine their imminent death with no hope of an after-life. Moreover, we were careful to chose an inevitable death scenario that was also sufficiently schematic and detailed (“imagine you are in a Texas jail”, “you are on death-row”, “your request for clemency has been rejected”, etc.) to ensure optimal comparison with the survival scenarios (Burns et al., 2014a). As in the previous study, we also included the World-War-III and life-after-death conditions.

The main finding was that the “death-row” condition led to lower recall than the World-War-III and life-after-death conditions, and similar recall to the ancestral survival condition. Thus, in accordance with the mortality-salience account, one dying scenario (death-row) yielded equally good recall as the original grassland survival scenario. Given that the congruency of items with the scenario has been put forward to account (in part) for survival effects in memory (e.g., Butler,

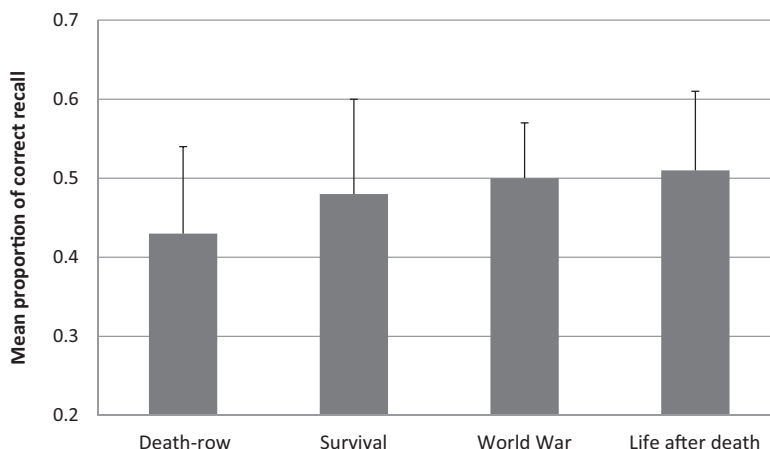


Figure 3. Mean proportions and standard deviations of correct recall as a function of encoding conditions in Study 3.

Kang, & Roediger, 2009, but see Nairne & Pandeirada, 2011), and as the relevance ratings of the words in the death-row condition were the lowest compared to the other conditions, the lower recall in the “death-row” condition compared to the World-War-III and life-after-death conditions could be due lower congruency. However, congruency cannot account for the whole pattern of recall rates, as the death-row condition yielded a lower relevance rating score than the survival condition but equal recall rates. It might also be the case that the death-row scenario is implausible for most people, because they do not think that they will ever be concerned by death row. As a result, this would reduce self-relevance. Given that self-relevance encoding is beneficial to long-term retention (Gutchess et al., 2007), this might explain the low recall rate in this condition. However, as Study 4 will show, the ratings of death-related thoughts were more often activated for oneself than for other people, which suggests that the self is to some degree activated. However, we acknowledge that being involved in a war or facing terminal illness (Burns et al., 2014a) is certainly more plausible than being on death row.

However, and this time contrary to the hypothesis that thoughts of death might underlie the classic (ancestral) survival effect in retention, the ratings on the explicit activation of thoughts of death revealed that the lowest rating on this dimension was precisely in this condition. Moreover, the mean response was not far from Response 2 corresponding to “thoughts of death only slightly activated”. Importantly, we also found that the different ratings suggest that these effects were not due to differences in emotional, interest or valence aspects of the scenarios. The findings of Study 3 are therefore balanced and do not simply support or refute the idea that part of the survival processing effect in long-term memory is due to mortality salience. In an attempt to clarify the situation regarding the mortality salience account of survival effects in memory, we therefore decided to run a fourth and final Study.

STUDY 4

The findings collected thus far are somewhat mixed regarding the hypothesis that the survival effect in memory is underpinned by the activation of death-related thoughts. On the one hand, certain findings support this hypothesis. In

particular, we were able to replicate the finding of Hart and Burns (2012) that mortality salience enhances recall (Study 1). Moreover, we found that recall in dying scenarios that stimulated more thoughts about death than the original grassland survival scenario was better than (Studies 2 and 3) or similar to (Study 3) recall in the grassland survival scenario. This finding is precisely in accordance with Klein’s (2014) assumption that if survival processing induces a mortality salient state that mediates the survival processing effect, a dying scenario that precludes the possibility of survival (our death-row scenario) should enhance retention to the same extent as the ancestral survival scenario. On the other hand, even though the death-row and the ancestral survival scenarios yielded similar recall rates, the ratings on the explicit activation of death-related thoughts in Study 3 showed that the ancestral survival scenario induced fewer thoughts of death than the “death-row” condition. Finally, correlation analyses showed no reliable relationship between the proportion of correct recall for each encoding condition and death ratings ($ps > .05$).¹ This finding is problematic for the mortality salience hypothesis of ancestral survival effects. It is worth mentioning that Klein (2014) also reported that the ancestral scenario yielded lower rating scores of thoughts of death than the death scenario. As Hart and Burns (2012) have noted repeatedly, it is also possible that mortality salience induces thoughts of survival. Alternatively, it may be that both survival processing and death processing (or mortality salience) activate some other mechanism or process that is responsible for enhanced recall. However, whether or not the death-row scenario yields thoughts of survival was not directly assessed among the participants in Study 3; it was simply inferred that it did not, because the instructions did not mention the possibility of survival after death.

To gain a clearer picture of the pattern of findings of Study 3, we collected additional ratings on the dimension of thoughts of death and

¹To further investigate the finding that thoughts of death did not impact correct recall, we performed median-split analyses on the ratings of death-related thoughts. Thus, for each encoding condition, we created two groups: a low and a high death-related thought group. The analyses did not reveal that the recall rates varied reliably as a function of high- versus low-death ratings.

survival. However, instead of asking for a “general” activation of death-related thoughts, we gave participants one scale to evaluate the activation of thoughts of their own death and another scale to evaluate the activation of thoughts of the death of other people (including their close relatives). They completed similar scales for thoughts of survival. We used exactly the same 4-point scales as Klein (2014) in order to compare our findings directly with those he obtained for thoughts of death and survival in the ancestral scenario. Given the assumption that planning processes play a role in the emergence of survival effects in memory (Klein et al., 2011), we also collected ratings on these dimensions for each scenario. Finally, in order to determine whether familiarity and imagery played a role in the recall rates found in Study 3, we also collected ratings on these two dimensions.

Method

Participants. Eighty-four students at the University of Bourgogne participated in the study. All participants received course credit for their participation.

Stimuli. The word list was the same as that used for Studies 2 and 3.

Procedure. The four encoding conditions used in the present study were the same as in Study 3. Participants were assigned to one of the four encoding conditions and were asked to perform several rating tasks. First, in contrast to the 5-point scale used in the previous studies, they had to evaluate on a 4-point scale (1 = not relevant at all, 4 = very relevant) the extent to which each word was relevant to the situation described in the scenario. They were then given a word-completion task in order to introduce a delay before the other rating tasks. After that, they were again presented with the scenario on which their first ratings were based and were asked to make seven different ratings on the same 4-point scales as those used by Klein (2014). Two scales were related to death-related thoughts (one related to the thoughts of their own death and the second to the death of other people including close relatives), and two were related to survival-related thoughts (one related to their own survival and the second to the survival of other people including close relatives). Another scale concerned planning related

thoughts. Finally, there was one scale on the ease of imaging the situation described by the scenario and another on familiarity with the situation depicted in the scenario. The order of the rating scales was varied.

Results of Study 4

The means and standard deviations for ratings and dimension ratings corresponding to the four scenarios are provided in Table 1. Separate ANOVAs were performed on each measure.

For the relevance rating scores, a reliable main effect of type of scenario was found, $F(3, 80) = 13.38$, $\eta_p^2 = .33$. Newman-Keuls tests indicated that all the conditions differed from the “death-row” condition.

We conducted separate ANOVAs on the ratings of death-related and survival-related thoughts, imagery, familiarity and planning. For death thoughts, a reliable main effect of the type of scenario was found on own-death ratings, $F(3, 80) = 6.51$, $\eta_p^2 = .19$, and on other-death thoughts, $F(3, 80) = 3.14$, $\eta_p^2 = .10$. On these latter measures, Newman-Keuls tests showed that the ratings for the ancestral survival scenario were reliably lower than the other scenarios, but they were not reliably different from the modern survival situation for own-death thoughts. For survival-related thoughts, a main effect of the type of scenario emerged on own-survival thoughts, $F(3, 80) = 10.14$, $\eta_p^2 = .27$, indicating that both the ancestral and modern survival scenarios were reliably higher than the life-after-death or “death-row” scenarios. The effect of the type of scenario was not reliable on other-related thoughts, $F(3, 80) = 2.61$, $\eta_p^2 = .19$. For planning ratings, the main effect of the type of scenario was also significant, $F(3, 80) = 9.00$, $\eta_p^2 = .25$, with both the ancestral and modern survival scenarios being reliably higher than the life-after-death and “death-row” scenarios. For imagery ratings, the type of scenario factor was reliable, $F(3, 80) = 2.89$, $\eta_p^2 = .10$. Newman-Keuls tests showed that only the World-War-III scenario was judged as reliably more imageable than the “death-row” scenario. Finally, with regard to familiarity ratings, a main effect of the Type of scenario factor was found, $F(3, 80) = 3.70$, $\eta_p^2 = .12$, and the Newman-Keuls comparisons revealed that the World-War-III scenario was judged as more familiar than all the other scenarios.

Discussion of Study 4

The findings from Study 4 can be easily summarised. The thoughts of one's own death were less numerous when encoding the words in relation to survival (in both the ancestral and modern situations) than when encoding the same words in relation to death (death-row and after-death scenarios). In contrast, there were more thoughts of own-survival when processing the survival than the dying scenarios. When the ratings of thoughts of death concerned the death of other people (including close relatives), we found that death-related thoughts were less numerous in the ancestral survival scenario than in all the other scenarios which gave rise to similar levels of death-related thoughts. For survival-related thoughts in connection with the survival of other people, there were no reliable differences across the different scenarios. The implications of the pattern of findings concerning death-related and survival-related thoughts for the mortality salience hypothesis of the survival memory effect will be examined below in the General Discussion. With regard to planning, we found that there were reliably more thoughts of planning in the two survival scenarios than in the two dying scenarios. This pattern of results is in accordance with Klein (2013), who found that the level of planning process varies according to the type of survival scenario. Our findings extend this observation to a modern survival scenario such as World War III.

With regard to relevancy rating scores, we found that these were lowest for the death-row scenario. In the Discussion of Study 2, we suggested that the modern survival scenario was more likely to evoke certain specific emotions and images, because participants are frequently confronted with war-related emotions and images via the media (TV, films, books or memories recounted by people, e.g., grandparents, who have experienced war). Thus, we postulated that the World-War-III scenario was more familiar and easier to imagine and that these characteristics could facilitate the encoding of the words. Ratings showed that the World-War-III scenario was the most familiar. (The only reliable difference in imagery ratings was that the World-War-III scenario was rated as easier to imagine than the "death-row" scenario.) Thus, it is possible that the better memory performance for the World-War-III scenario compared to the ancestral and death-row scenarios is in part related to the

familiarity dimension that facilitated encoding and retrieval of information.

GENERAL DISCUSSION

Nairne (2010; Nairne & Pandeirada, 2010a, 2010b) adopted a functionalist view of memory whereby memory systems exist in their current form, because this arrangement helped to solve recurrent problems faced by humans in their ancestral past. This view opposes a more traditional view whereby human memory systems possess domain-general memory mechanisms such that retention systems operate in the same way across stimuli and domains and are not modified by information content (Nairne, Vasconcelos, & Pandeirada, 2011). The so-called "survival effects" have lent some support to the functional view of memory. When words are processed in relation to their relevance for survival, there are clear memory benefits which are not observed when the same items are processed in relation to other types of relevance (e.g., Nairne et al., 2008). The seminal work of Nairne and co-workers (Nairne et al., 2007) has stimulated an impressive number of studies.

The goal of the present research was to test the hypothesis that survival effects could be attributable to the fact that the traditional ancestral survival scenario used by Nairne et al. (i.e., survival in grasslands) has the potential to activate thoughts of death, and that this kind of activation is responsible for these effects. As explained in the Introduction, this hypothesis was brought to our attention by the studies of Soderstrom and McCabe (2011) and Hart and Burns (2012). Soderstrom and McCabe (2011) suggested that the survival effect might be related to the activation of thoughts of death, while Hart and Burns (2012) reported that the retention of unrelated words improved when the thought of our own death was made salient prior to encoding words in comparison with a situation where the same words were encoded after activating other types of thought (e.g., watching TV, imagining being paralysed). Importantly, the idea of a functional connection between death and survival encoding scenarios has also been investigated in several very recent studies (Bell et al., 2013; Burns et al., 2014a, 2014b; Klein, 2014). However, to date, there is no clear evidence supporting this view. We therefore examined this issue in four studies and the findings can be easily summarised.

In the first study, we replicated the DTR effect initially found by Hart and Burns (2012) and Burns et al. (2014b). In Study 2, we compared the retention of unrelated words under four different encoding conditions: two survival scenarios (ancestral and modern), a dying scenario (life-after-death), and a deep encoding control condition (pleasantness). The pleasantness condition yielded the lowest recall score. There was no reliable difference in recall performance between the life-after-death and the World-War-III scenarios. Finally, the World-War-III and the life-after-death scenarios had higher recall rates than the grasslands scenario. It must be made clear that the DTR effect found by Hart and Burns (2012) and replicated in Study 1 is more of a priming effect than a processing effect per se, because participants think first about death and only process unrelated words once death thoughts have been activated.² (It is in fact conceivable that the effects on recall of DTR differ, at least in part, from those of death-processing scenarios like the ones we used in Studies 2 and 3.)

The same scenarios were used in Study 3, apart from the pleasantness condition which was replaced by a more salient death scenario, in which participants had to imagine they were on death row and that their request for clemency had been rejected and they were about to be executed. We found that the recall rate for this scenario was lower than both the World-War-III and the life-after-death scenario and was similar to the recall rate of the ancestral survival condition. As suggested in the Discussion of Study 3, the death-row scenario might appear less plausible for most participants than the World-War-III scenario in that there is a greater chance of being involved in a world war than of being on death row. Additionally, it is possible that this scenario does not encourage the kind of “abstract reflection” about the experience of being a mortal elicited by other more plausible scenarios or encouraged by the classic mortality-salience induction used in the TMT literature (i.e., writing about the emotions aroused when thinking about your own death and what will happen to you when you physically die) and which may be important in the DTR effect.

Importantly, in Study 3, we also collected ratings of death-related thoughts, which revealed that the lowest rating on this dimension was in the

ancestral survival condition (the mean response was in fact similar to “thoughts of death only slightly activated”). The “death-row” encoding condition yielded higher ratings of thoughts of death than the ancestral survival, life-after-death and World-War-III conditions. The “death-row” and World-War-III conditions did not reliably differ. Although the finding of similar recall rates in the ancestral and death-row scenarios in Study 3 accords with the hypothesis of overlapping mechanisms underlying survival and dying encoding scenarios, the death-thought ratings that were collected after all the words had been presented produced a pattern of results that was rather inconsistent with the interpretation that mortality salience is the sole factor responsible for the survival processing effect. However, consistent with the mortality salience hypothesis, the ratings showed that the modern survival scenario produced higher ratings of death thoughts than the ancestral scenario and also produced better recall. We also found in Study 3 that the scenarios did not differ reliably in emotion, interest or valence.

Finally, the aim of the fourth study was to clarify the pattern of findings of Study 3. Additional ratings on the dimension of thoughts of death and survival were collected. In particular, the addition of survival ratings was motivated by Hart and Burns’ (2012) suggestion that mortality salience has the potential to activate thoughts of survival that play a role in memory performance. In Study 4, participants were told to evaluate not the thoughts of death in general as in Study 3, but the activation of the thoughts of their own death together with activation of the thoughts of the death of other people (including their close relatives) on two separate scales. The procedure was repeated for thoughts of survival. For direct comparison with Klein’s (2014) findings, the same 4-point scales were used. Since it has been assumed that planning processes may play a role in the emergence of survival effects in memory (Klein, 2013; Klein et al., 2011), we also collected ratings on the planning dimension for each scenario. Finally, we collected ratings of familiarity and imagery for each scenario to evaluate whether these dimensions played a role in the pattern of recall rates observed in Study 3. Study 4 yielded several findings that we think are not easy to reconcile with the mortality salience account. First, Study 4 made clear that participants’ thoughts of their own death were activated less when encoding words for survival (in both ancestral and modern

²We thank an anonymous reviewer for pointing this out.

situations) than when encoding the same words in relation to death (in both the after-death and death-row scenarios). Secondly, the reverse pattern was found when the words were rated for thoughts of own-survival. This pattern of findings is the same as the one reported by Klein (2014). He found that his dying scenario (in which participants were simply told to imagine that they were about to die) led to less survival-related thoughts than the ancestral scenario, whereas the reverse was found concerning death-related thoughts. In addition, he also reported more thoughts of planning in the survival than in the dying scenario, exactly as we found in Study 4. It is worth remembering that Klein et al.'s (2011) work had already shown that planning played a causal role in the survival processing advantage in long-term memory. In accordance with Klein (2014), the findings on thoughts of planning agree with the idea that the mortality salience scenarios used in Studies 3 and 4 tend to evoke feelings of a passive, unpleasant outcome, whereas the survival situations (ancestral and modern situations) induce a more proactive stance in which people consider options potentially able to avoid an unpleasant outcome. Thirdly, the level of own-death thoughts reported by participants was similar in the ancestral and the modern survival scenarios. (Indeed, 62% of the participants selected the scale value of "not at all" in the ancestral scenario.) The similarity of the ratings of thoughts of survival, death and planning between Klein's (2014) study and our Study 4 is striking and suggests a similar conclusion about the influence of death on the memory benefit of survival processing.

We are aware that to explain in greater depth the pattern of recall results found in Studies 2 and 3 will require additional studies to investigate the proximate mechanisms at play in the different scenarios. In effect, it is not easy to parse the mechanisms (i.e., planning, self-relevance, richness of encoding) that underlie a memory effect (e.g., survival effect, DTR effect) and then to ascertain the relative contribution of each. As far as the survival effect is concerned, there have been some attempts to investigate the underlying proximate mechanisms, and some have been identified as potential candidates, including richness of encoding and self-encoding (see Erdfelder & Kroneisen, 2014 for an overview). However, identifying the proximate mechanisms (and their specific contributions) that sustain the survival processing advantage in memory is an issue that requires more in-depth studies.

OTHER STUDIES INVESTIGATING THE RELATIONSHIP BETWEEN DEATH AND SURVIVAL PROCESSING

As mentioned in the Introduction, recent studies in memory research have drawn different conclusions about the influence of death thoughts on the survival processing advantage in memory.

Hart and Burns' (2012) study, already described extensively, found that merely contemplating one's death improves retention for entirely unrelated material learned subsequently. To our knowledge, Hart and Burns (2012) were the first to identify the influence of mortality salience on long-term retention—the DTR effect. Thus far, this effect has never been replicated by an independent group of researchers. In Study 1, we successfully replicated Burns and co-workers' findings (Burns et al., 2014b; Hart & Burns, 2012) that mortality salience improves long-term retention. Replicating these findings was important for any discussion about the role of the activation of thoughts of death in the survival effect. According to Hart and Burns (2012), the DTR effect seems to be conceptually related to the ancestral survival processing effect, whereby processing items for their relevance to being stranded in grasslands leads to better recall than other deep processing control conditions.

From a general standpoint, the hypothesis that mortality salience yields specific behavioural outcomes in humans compared to other negative and/or emotional scenarios stems from Terror Management Theory (TMT). TMT (e.g., Greenberg et al., 1986; Hayes et al., 2010) assumes that humans, like other living creatures, possess a basic orientation towards survival. However, unlike other animals, humans possess the capacity for self-reflective thought, which leads them to become aware of their own finitude, in other words, that they are certain to die in the future. This awareness, when coupled with the desire to continue living, creates the potential for existential anxiety or terror. In order to insulate themselves from this existential terror, humans rely on different proximal and distal mechanisms (e.g., Pyszczynski et al., 1999). According to TMT theorists, cultural belief systems imbue life with a sense of meaning, purpose and stability. These cultural worldviews mitigate death-related anxiety by providing an explanation of human existence and a way of acquiring self-worth by adhering to cultural values and norms. The desire to pursue life (i.e.,

survival) and not thinking too much about the fact that life must necessarily come to an end are two fundamental issues that require humans to adopt adaptive behaviours. In particular, if death concerns are not managed effectively, chronic direct contemplation of one's unavoidable demise could be psychologically crippling and a waste of resources (Hart & Burns, 2012). In particular, evidence has been reported (in more than 350 laboratory studies conducted in 16 countries according to Chatard et al., 2011) that in order to manage this distress, people are motivated to maintain faith in their cultural worldview and to maintain positive self-esteem (e.g., Hansen et al., 2010). These behavioural outcomes are not observed when other types of aversive thoughts are made salient (e.g., dental pain, failing an exam).

According to Burns et al. (2014b), if both survival and the DTR effect are underpinned by similar proximate mechanisms, we should observe redundancy in mortality and survival processing. They tested this proposal in an experiment in which either the thought of death or dental pain was induced in participants who then had to rate words on either their pleasantness or their survival value. Interestingly, in accordance with their hypothesis, the mortality salience group recalled more words than the dental pain group—a DRT effect, but this effect did not show up when words were rated for survival relevance. This finding is certainly a convincing argument in favour of the mortality-salience explanation of the survival processing effect. However, even though in the domain of episodic memory, there is other empirical evidence that supports the redundancy hypothesis (e.g., McDaniel, Waddill, Finstad, & Bourg, 2000), that study does not explain exactly how redundancy eliminates the influence of common processes.

In another study, efforts were made to match the dying scenarios and the survival scenarios on several critical dimensions (thematic structure, concreteness and relevance). Interestingly and importantly, Burns et al. (2014a) found that recall rates were similar, suggesting that overlapping mechanisms are involved in the two types of encoding situation. A potential issue in that study is that, in their Experiments 1 and 2, the dying scenario took the form of participants being told that they had just been diagnosed as being terminally ill, with no hope of surviving or extending their life. Paradoxically, one study in the TMT literature found that “terminally ill”,

which is strongly associated with cancer which is often construed as a death sentence, did not increase death-related thoughts (Arndt, Cook, Goldenberg, & Cox, 2007). It therefore remains a possibility that this choice of wording in Burns et al. (2014a) study had the unfortunate outcome that it did not activate thoughts of death.

Let us now turn to studies supporting the hypothesis that survival and DTR processing effects are partly or totally independent. Bell et al. (2013) compared the ancestral survival situation with a situation where adults had to imagine that they had decided to commit suicide and were instructed to evaluate words for their relevance in such a situation. A moving-home scenario and a pleasantness condition were also included. Contrary to the hypothesis of overlapping processing in the survival and dying scenarios, survival processing yielded an advantage in recall performance over the other conditions. Although these findings are interesting, activating the idea of suicide, although this implies death, is not the same as activating thoughts of death per se. In the TMT literature, there is evidence that suicide salience does not lead to the same behavioural outcomes as mortality salience (Chatard & Selimbegovic, 2011). Finally, in Bell et al.'s (2013) Experiment 3, participants rated words for their relevance to either death or survival. A good point was therefore that exactly the same rating task was used in both the survival and death conditions. However, we believe that it may be more difficult to rate words for their relevance to death than their relevance to survival (e.g., what does it mean for a word such as chicken, apple, or razor to be relevant to death? And whose death is concerned?). Interestingly, Bell et al.'s (2013) findings suggest that the survival processing advantage cannot be attributed to “merely contemplating death”, as Hart and Burns (2012) proposed, and other processes (e.g., elaborative encoding or self relevance) also seem to play an important role.

Finally, according to Klein (2012), the conditions that existed when the memory mechanisms underlying survival-relevant behaviours developed differed dramatically from those when our ancestors first began to develop awareness of their own finitude. Based on these evolutionary arguments, Klein queried whether a conceptual relationship between thoughts of death and thoughts of survival can translate into a functional relationship. Klein's (2014) study argues against the hypothesis of overlapping mechanisms in survival and dying processing, based on the finding that processing

words in terms of survival produced a higher level of recall than processing them in terms of death. Also, as described above, when reviewing the findings of our Study 4, the ratings of thoughts related to death and survival were not in line with the mortality salience account of the survival memory advantage.

According to Klein (2014), one possibility is that Hart and Burns' (2012) study used scenarios whereby death was primed in a way that did not prompt thoughts of active avoidance as could be the case in survival scenarios. However, as he pointed out, finding equivalent recall in a scenario involving active avoidance of death and in a survival scenario would not automatically support a functional equivalence. We agree with Klein (2014) that comparable levels of recall do not automatically licence the conclusion of process identity. Indeed, from a general standpoint, inferences about the specific mechanisms underlying recall effects are very hard to draw from overall recall. It is not possible to know whether two processing conditions that elicit identical recall owe their effects to the same mechanisms. Conversely, we cannot know whether two processing conditions that yield different recall results do so because they recruit different mechanisms, because it could simply be the result of different amounts of the same mechanism, although there is evidence suggesting that repeating the same mechanism (redundancy; Burns et al., 2014) does not yield additional benefits for memory performance (e.g., Hunt & Einstein, 1981; McDaniel et al., 2000).

Our findings in Study 3 showed recall equivalence between the death-row and the ancestral survival scenarios, but, at the same time, Study 4 demonstrated a clear difference between the ratings of death- and survival-related thoughts. While thoughts of survival were activated in the ancestral but not in the death-row scenario, thoughts of death were not activated more (remember that the mean scaled value was virtually similar to the response "not at all activated") in the ancestral scenario. Given this observation, it is hard to argue for a strong functional similarity between the two scenarios, unless one dismisses the value of subjective ratings. However, to assume that subjective ratings (of death, survival-related thoughts, etc.) are not trustworthy would require a complete re-evaluation of many (if not virtually all) of the studies conducted on adaptive memory which have generally made extensive use of such ratings to support or discard certain

interpretations related to survival effects. We nevertheless suggest that future studies should aim to use implicit measures of death-thought activation as used in the TMT literature. One such measure could be lexical decision response times to death-related words compared to negative or neutral words (e.g., Hayes, Schimmel, Faucher, & Williams, 2008).

Limitations of the survival effect

The survival effect on memory has been reported in a number of studies in different countries (e.g., the USA, Japan, Germany) and involving different populations (young and older adults; children) and is therefore a robust finding. However, as is often the case with novel (and somewhat provocative) findings, there have also been several attempts to determine whether these effects are truly attributable to the processing of items in terms of their adaptive value or are in fact survival effects in disguise. According to the latter interpretation, the survival effects found in long-term retention are due to the fact that encoding words during a survival scenario has the potential to instantiate types of processing that are beneficial to long-term retention in general but are not specifically related to adaptive issues.

Recently, several studies have also shown that the survival advantage is operative within certain boundaries (Otgaar et al., 2011). Thus, the advantage of survival processing in long-term encoding over all other deep encoding conditions is not always found. Here, in Study 1, we replicated the recall advantage of survival processing over the deep encoding pleasantness condition found in previous studies (Nairne & Pandeirada, 2008a, 2008b, 2010a; Nairne et al., 2007, 2008, 2009;). However, it has been observed that this enhanced retention due to encoding words in a survival scenario is not always found when compared with control conditions previously found to be generally less optimal, for example self-reference (see Klein, 2012). Although the survival effect has been found with a scenario in which the context supposedly activates our ancestral environment, it is also noteworthy that some studies have failed to replicate the finding of higher recall performance in ancestral than modern-day survival scenarios (Soderstrom & McCabe, 2011). Furthermore, in the present research, we found that the World-War-III scenario yielded better long-term retention than the ancestral survival scenario. It is

important to emphasise that our studies show how (ostensibly) easy it is to obtain survival processing-like effects using scenarios that are quite different from the original grasslands survival scenario.

We think that the functional view of memory put forward by Nairne (2010; Nairne & Pandeirada, 2010b) is valuable in that it has forced memory researchers to think about memory processes in terms of *why* these processes are as they are (the function they serve) and not only in terms of *how* they operate. More recently, VanArsdall, Nairne, Pandeirada, and Blunt (2013) and Nairne, VanArsdall, Pandeirada, Cogdill, and LeBreton (2013) have reported another type of evidence for a functional view of memory. Rather than manipulating the type of encoding, these researchers used items that varied along the animate-inanimate dimension and found that animate items were better remembered than inanimate items (see also Bonin, Gelin, & Bugaiska, *in press* for further evidence). This finding strongly supports the functional view of memory, since the ability to detect and memorise animate items was beneficial for survival in our ancestral past (Nairne & Pandeirada, 2010a, 2010b).

To conclude, the current findings concerning the connection between survival, death and long-term memory do not readily support the idea that the survival effect is underpinned by activation of thoughts of death. The implication of our studies regarding the relationship between DTR and survival effects is therefore that they are not exactly the same. However, we are aware that these findings (like those obtained in previous studies on this issue) do not definitively demonstrate that there is little or no overlap between survival and death processing. Our findings, while replicating the beneficial influence of thoughts of death on memory initially reported by Hart and Burns (2012), suggest a promising avenue for memory researchers who would like to investigate the proximate mechanisms that underlie this thought-of-death memory effect.

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