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Negative memories serve functions in both adaptive and maladaptive ways

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Negative memories serve functions in both adaptive and maladaptive ways

Autobiographical memories are said to serve at least three functions: they direct people's behaviour, inform their identity, and facilitate social bonding and communication. But much of the research on these three functions has not distinguished between memories that serve functions in adaptive ways from those that serve functions in maladaptive ways. Across two experiments, we asked subjects to provide either positive or negative memories. Then, to operationalize adaptive and maladaptive functions, we asked subjects to rate the extent to which those memories serve directive, self, and social functions in ways that "help" and in ways that "hurt." To investigate whether people believe the adaptive benefits of their memories outweigh any maladaptive effects, we also asked subjects how willing they would be to erase the memories if given the opportunity. We found that negative memories served functions in both helpful and hurtful ways, whereas positive memories were primarily helpful. Furthermore, the more helpful a memory was, the more reluctant subjects were to erase it. Conversely, the more hurtful a memory was, the more willing subjects were to erase it. These results suggest it is important to distinguish between adaptive and maladaptive functions when investigating the functions of autobiographical memory.

Keywords: autobiographical memory; function; maladaptive; negative memory; posttraumatic growth

Athlete-turned-actor Dwayne "The Rock" Johnson often tells the story of his "Seven bucks moment." All his life, Johnson dreamed of playing professional football. After an injury kept him out of the US National Football League, Johnson joined the practice squad of the Canadian Football League's Stampeders (Johnson, 2016). But not long afterwards, the Stampeders cut him from the team. In that moment, Johnson saw a lifetime of dreams vanish: "I left home when I was 18 and promised my family I'd make something of myself. Now 5yrs later at 23, I'm moving right back in with my parents, a failed football player with just 7 bucks in my pocket. Dream over" (Johnson, 2018). Johnson fell into depression, sitting at home on his couch with no idea what to do with his life. It was The Rock's "rock bottom." Given how painful this experience was, we might expect The Rock would jump at the chance to rid himself of this negative memory.

As it turns out, though, he would not. On the contrary, he is so fond of the memory that he even named his production company "7 Bucks Productions." But why? One possibility is that memories—even negative ones—serve adaptive functions. Evidence from the autobiographical memory literature shows that people's memories serve at least three broad functions—they direct people's thinking and behaviour, help people maintain a sense of self and identity, and are shared with others in social contexts to help form and strengthen relationships (Bluck & Alea, 2002; Cohen, 1998; Hyman & Faries, 1992; Pillemer, 1992).

It has also been proposed that autobiographical memories can serve other functions, such as regulating emotions (e.g. Kulkofsky, Wang & Hou, 2010; Pasupathi, 2003) and providing a sense of social identity (e.g. Berntsen, 2009; Rasmussen & Berntsen, 2009; Wright & Gaskell, 1992). In the reminiscence literature, more specific

functions such as teaching others and maintaining intimacy have also been subject for systematic research—these functions have been viewed as sub-categories of the three broad functions (e.g. Bluck & Alea, 2002; Cappeliez, O'Rourke, & Chaudbury, 2005; Webster, 2003).

It is not just people's positive memories that can serve these various functions. In fact, people tend to rate their negative memories as more directive than their positive memories, and researchers have suggested that even the most traumatic events can serve adaptive functions (Pillemer, 2003; Rasmussen & Berntsen, 2009). Furthermore, it has been shown that negative memories sometimes have redemptive qualities (McAdams, Reynolds, Lewis, Patten, & Bowman, 2001) and can serve as turning points in the life story (Pillemer, 2001; 2003; see also Habermas & Bluck, 2000 for similar views). The Rock, for example, used his "seven bucks" memory to motivate him to do more with his life (Johnson, 2016).

But negative memories can also be maladaptive in a variety of ways. After all, we know that thinking back to negative experiences can produce strong negative emotions (D'Argembeau, Comblain, & Van der Linden, 2003). In extreme cases, negative memories are even related to psychopathology—for example, rumination is associated with depression (Nolen-Hoeksema, 2000), and there is evidence that the characteristics of people's memories for a trauma contribute to the development of PTSD (Rubin, Dennis, & Beckham, 2011). Furthermore, research on reminiscence functions has identified specific uses of memory that are sometimes maladaptive, such as bitterness revival and boredom reduction (Harris, Rasmussen, & Berntsen, 2014; Webster, 2003).

But memories could also be maladaptive in ways that map onto the directive, self, and social functions of memory. Although it might generally be adaptive for memories to serve these three functions (e.g. Bluck, Alea, Habermas, & Rubin, 2005), it is possible that some instances in which memories serve these functions could be maladaptive. Take, for example, an alternate reality where The Rock's "rock bottom" memory led him to give up on his dreams and stay on his couch. In that case, The Rock's memory is serving a directive function by guiding his behaviour, but is doing so in a way that is maladaptive. Likewise, if the memory led him to think that he is incapable of succeeding, we might then consider the memory as serving a self function in a way that is maladaptive. Finally, if the Rock had complained to others about his experiences in a way that made people annoyed or frustrated with him, we might think of the memory as serving a social function in a way that is maladaptive (see Pillemer, 2003 for similar examples). For the sake of brevity, we will henceforth refer to memories that serve functions in ways that are adaptive as serving *adaptive functions* and memories that serve functions in ways that are maladaptive as serving *maladaptive functions.*

Surprisingly, we know little about the extent to which people's memories serve directive, self, and social functions in ways that are maladaptive. One reason for this gap is that the literature investigating the directive, self, and social functions of autobiographical memory tends to rely on measures that focus primarily on the ways people's memories are adaptive, or that do not separate adaptive and maladaptive outcomes. Take, for example, a study that measured the self function by asking people to rate the degree to which "this memory tells me something about my identity" (Rasmussen & Berntsen, 2009). This item cannot, of course, tell us whether people's

memories are shaping their identity in ways that are adaptive or maladaptive. Likewise, more extensive survey measures that use more than one item to address the three broad functions largely do not differentiate between adaptive and maladaptive usage (e.g. Bluck & Alea, 2011; Webster, 2003). This insensitivity to the maladaptive contributions of people's memories is a problem that cuts across the literature as a whole (see, for example, Kulkofsky et al., 2010; McLean & Lilgendahl, 2008; Pillemer, Steiner, Kuwabara, Thomsen, & Svob, 2015).

It makes sense that in trying to understand why we have autobiographical memories, research has focused on adaptive usage. After all, trying to understand the adaptive advantage a behaviour or process confers on us is an important part of psychological science (see, for example, Bruce, 1985; Suddendorf & Corballis, 2008). But without a full understanding of the ways in which autobiographical memories are maladaptive, it is hard to know the extent to which autobiographical memories are, on the whole, adaptive. Indeed, a landmark paper published more than a decade ago addressed function in terms of everyday usage, but encouraged scientists to distinguish between adaptive and maladaptive ways of using memory in future research: "A later development in any program of research on function would be the identification of adaptive and maladaptive ways in which memory is employed in everyday life" (Bluck et al., 2005, p. 92). The present experiments aim to address this gap by examining the adaptive and maladaptive ways people's memories serve directive, self, and social functions in everyday life.

More recently, the field was urged to take a broader view of the functions of autobiographical memory, including the idea that functions can be thought of as "reasons for remembering" that could be adaptive or maladaptive (Del Palacio-

Gonzalez, Watson, & Berntsen, 2018; Harris et al., 2014). But we still know little about the relative adaptive and maladaptive contributions of people's memories. To what extent do people's memories serve directive, self, and social functions in adaptive and maladaptive ways? To answer this question, we conducted two pre-registered experiments in which we asked people to provide either positive or negative memories. In each experiment, we asked subjects to report the extent to which the memories "help" them and "hurt" them in ways that map on to the directive, self, and social functions of autobiographical memory.

Of course, even if a memory is maladaptive, it could still be that the adaptive benefits of that memory outweigh its maladaptive effects. We might expect, then, that people want to hold on to adaptive negative memories—as The Rock does with his "seven bucks" memory—but want to get rid of maladaptive negative memories. We tested this possibility by asking subjects how willing they would be to "erase" the memories they provided (in Experiments 1 and 2) and how willing they would be to "save" the memories forever (in Experiment 2).

Experiment 1

Method

Experiments 1 and 2 were both pre-registered—analyses that were not pre-registered are noted as exploratory. The pre-registrations, supplemental materials, and data for the two experiments is available at osf.io/y6vg2/

Subjects

We recruited workers from the United States and Canada on Amazon's Mechanical

Turk platform (https://www.mturk.com/) through TurkPrime (Litman, Robinson, & Abberbock, 2017). Subjects participated in exchange for $0.20 Amazon credit. We aimed to collect data until we had 400 useable data points, after exclusions. Because of the way Mechanical Turk interacts with Qualtrics, 418 subjects completed the survey, 4 of whom did not provide autobiographical memories, and a further 4 who did not pass the attention check[1]. The final dataset included 410 subjects ($M_{age} = 41.25$, $SD = 13.42$) of whom 150 identified as men, 257 as women, and 3 as gender diverse. All but five of our subjects reported that English was their primary language. Those five subjects reported their primary language as Italian, Urdu, Chinese (two subjects), and Spanish.

Design

We manipulated the type of memory subjects brought to mind (most positive, most negative) between subjects.

Procedure

This experiment was approved by the University of Waikato's School of Psychology Research and Ethics Committee under delegated authority of the University's Human Research Ethics Committee. We conducted this experiment in accordance with the World Medical Association Declaration of Helsinki.

The procedure took place in a single session, comprising five parts. First, we told subjects we were interested in people's memories for specific events that took place within 24 hours at a specific time and place that they personally experienced. Then, we asked some subjects to describe their most negative memory and other subjects to describe their most positive memory (see the Supplemental Materials for the full instructions). We asked subjects for negative memories because we reasoned that

negative memories are those most likely to be maladaptive (Nolen-Hoeksema, 2000; Rubin et al., 2011). We asked for positive memories to provide comparison memories that should be similar in emotional intensity, but have different valence.

Second, subjects rated the extent to which their nominated memory serves functions in ways that help them, and in ways that hurt them. To gather these data, we modified function items that have been used in the literature (Rasmussen & Berntsen, 2009; 2013). These items comprise one item for each of the directive, self, and social functions. We also included a fourth item measuring the social identity function, which addresses social bonding and a sense of belonging with others but without the memory having to be shared (see Berntsen, 2009; Wright & Gaskell, 1992). We modified these items because the original items do not separate whether a memory is serving functions in ways that are adaptive or in ways that are maladaptive, which was our main research interest. For example, we split the item "this memory tells me something about my identity" into two items ("this memory tells me something about my identity in ways that help me" and "this memory tells me something about my identity in ways that hurt me"). We repeated this modification for each item, so that the original four-item became an eight-item scale, with four items measuring the adaptive functions, and four items measuring the maladaptive functions (see Table 1 for the full list of these function items and their anchors). Finally, we created a sum variable for helpful functions by taking the mean of the four items measuring helpful functions and a sum variable for hurtful functions by taking the mean of the four items measuring hurtful functions.

Third, subjects completed a series of other ratings about their nominated memory. More specifically, as a manipulation check, we asked subjects to rate the valence of their memory on two items (see Table 1; Rubin, Schrauf, & Greenberg,

2003). Next, subjects completed an attention check and then rated how significant the memories were for their life story and how old they were when the event took place.

Fourth, we told subjects to imagine they had the opportunity to completely erase their nominated memory, meaning that the memory would be gone—they would not be able to bring to mind any aspect or aspects of what happened. We asked subjects to rate how likely they would be to erase the memory, and then to make a dichotomous yes/no decision about whether they would erase it (see the Supplemental Materials for the full instructions).

Finally, subjects answered basic demographic questions about their age, gender, and primary language.

Results & Discussion

Our primary research question was: to what extent do people's memories serve functions in ways that are adaptive and maladaptive? Before turning to this question, we first examined subjects' descriptions and checked that our manipulations were successful.

Descriptives & manipulation checks

Subjects' most negative memories took place at a mean age of 27.66 ($SD = 13.97$; Range = 3-65). In the mean, these memories took place 13.40 years ago ($SD = 13.51$). The descriptions were also fairly short ($M_{words} = 49.50$, $SD = 41.83$, Range = 2-365). Subjects rated their memories as highly negative ($M_{negativity} = 6.21$ $SD = 1.31$; $M_{positivity} = 1.42$ $SD = 0.94$), and significant to their life story ($M = 5.35$ $SD = 1.64$). Examples of negative memories subjects described included "I had a miscarriage" and "When my grandad died. It was really sad to me as the first major death in my life. It was very

unexpected and sad."

Subjects' most positive memories took place at a mean age of 27.78 ($SD =$ 13.40; Range = 3-72). In the mean, these memories took place 13.68 years ago ($SD =$ 14.34). The descriptions were fairly short ($M_{words} = 44.65$, $SD = 25.56$; Range = 4-147). Subjects rated their memories as highly positive ($M_{positivity} = 6.55$ $SD = 0.85$; $M_{negativity} =$ 1.30 $SD = 0.90$), and significant to their life story ($M = 5.79$, $SD = 1.46$). Examples of positive memories included "Giving birth to my son" and "when I married my husband. He is the best partner I could have asked for and I still can't believe he married me."

Function ratings

Before turning to our primary research question, we first examined the reliability of our adaptive and maladaptive sum variables. As expected, we found correlations among the helpful items and among the hurtful items, and both sum variables had good reliability ($\alpha_{helpful} = 0.83$, $\alpha_{hurtful} = 0.86$; see the Supplemental Materials for a detailed analysis of the correlations between the function items and the reliability of the sum variables).

We now turn to our primary research question: to what extent do people's memories serve functions in ways that are adaptive and maladaptive? Using the function sum variables, we first compared the helpful and hurtful function ratings of subjects who described their most negative memories. As the left-hand side of Figure 1 shows, subjects' negative memories were both moderately helpful ($M = 3.26$, $SD =$ 1.38) and moderately hurtful ($M = 3.71$, $SD = 1.47$). The relative mixture varied somewhat across the individual functions (see the Supplemental Materials), but overall subjects' memories were slightly more hurtful than they were helpful ($M_{diff} = 0.45$, 95% CI [0.17, 0.72]). These findings suggest that people's most negative memories are

neither wholly adaptive nor wholly maladaptive—instead, they tend to serve a mix of adaptive and maladaptive functions.

But do people's positive memories also serve this mix of functions? They do not. As the right-hand side of Figure 1 shows, subjects' most positive memories tended to be much more helpful ($M = 5.24$, $SD = 1.31$) than hurtful ($M = 1.56$, $SD = 1.02$; M_{diff} = 3.68 [3.45, 3.92]). In fact, these memories were at floor on hurtful functions. This pattern holds true across the individual functions (see the Supplemental Materials). Furthermore, we found that subjects' positive memories were more helpful than their negative memories (M_{diff} = 1.98 [1.72, 2.24]) and less hurtful (M_{diff} = 2.15 [1.90, 2.39]). These results suggest that unlike people's negative memories, their positive memories tend to be predominantly adaptive.

Willingness to erase the memories

Thus far we have established that people's negative memories serve functions in a mixture of adaptive and maladaptive ways, and that this mixture is not present in positive memories. But do people want to hold on to their negative memories—as The Rock does with his "seven bucks" memory—or would they rather forget them? If people believe the adaptive utility of their memories outweighs the maladaptive effects, we might expect people to want to hold on to them. But on the other hand, if people believe the maladaptive effects of their memories outweigh the adaptive utility, they might want to erase the memories. To answer this question, we analysed subjects' responses to two items. The first item asked subjects to rate how likely they would be to erase their nominated memory if they got the chance. The second item asked them to make a dichotomous yes or no choice about whether they would erase it.

First, we examined responses to these two questions from subjects who provided their most positive memory. Given that these memories are highly positive, and appear to be at floor on maladaptive functions, we expected that subjects would be unlikely to want to erase them. Indeed, subjects were overwhelmingly unwilling to erase their nominated memory—subjects' ratings of how likely they would be to erase their most positive memory were at floor ($M = 1.26$, $SD = 0.91$), and only 4 subjects out of 198 said they would erase it when asked to make a dichotomous choice. Perhaps unsurprisingly, these data show that people value holding on to their positive memories.

By contrast, when we examined responses to these two questions from subjects who provided their most negative memory, we found more varied responses. In the mean, it appeared that subjects were moderately willing to erase their most negative memory ($M = 3.56$, $SD = 2.42$). But a closer inspection of the distributions revealed a starkly bimodal distribution—subjects tended to be either highly likely or not at all likely to erase their most negative memory (see the Supplemental Materials for the full distributions). These results show that some people are highly willing to get rid of their most negative memory, whereas others are very reluctant do so. This split is reflected in subjects' responses to the dichotomous choice about whether to erase the memory— 61% said they would not erase the memory, while 39% said they would. Despite the fact that these memories were subjects' most negative memories, the majority would not want to erase them. Considered as a whole, these data suggest that many people value holding on to even their most negative memories.

Why, though, did subjects choose not to erase their most negative memory? One possibility is they believed the adaptive utility of these negative memories outweighs whatever maladaptive effects the memories carry with them. If this explanation were

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correct, we would expect that subjects' willingness to erase a negative memory would be related to the extent to which that memory serves functions in ways that are adaptive and maladaptive. Exploratory results provide evidence for this explanation. More specifically, the more helpful a negative memory was, the less willing subjects were to erase it ($r = -0.43$ [-0.51, -0.35]). Conversely, the more hurtful a negative memory was, the more willing subjects were to erase it ($r = 0.51$ [0.43, 0.57]) These results suggest that people want to get rid of negative memories that are maladaptive, but are reluctant to get rid of those that are adaptive. In turn, these results fit with the idea that many people believe the adaptive functions of their negative memories outweigh the maladaptive functions those memories serve.

Alternate explanations

Of course, our design means we cannot determine if adaptive and maladaptive functions are driving people's decisions about whether to erase their memories. One plausible alternative is that people simply want to erase memories that are highly negative, and that those memories also happen to be high on maladaptive functions and low on adaptive functions. To address this possibility, we conducted an exploratory logistic regression with helpful function, hurtful function, and negative valence predicting subjects' decisions about whether to erase their most negative memory[3]. This analysis showed that hurtful function was the strongest and only significant predictor of people's decisions. More specifically, the more hurtful a memory was, the more likely subjects were to want to erase it ($OR = 1.36$ [1.10, 1.69]). By contrast, the more helpful a memory was, the less likely subjects were to want to erase it, although this effect was not significant and the effect size is plausibly trivial ($OR = 0.81$ [0.64, 1.02]). There was

no strong evidence that valence predicted subjects' willingness to erase the memory ($OR = 1.18$ [0.91, 1.56]). These results provide evidence against the idea that valence is driving the relationships between functions and people's willingness to erase their most negative memory. Of course, there is a relationship between valence and functions— negative memories tend to be more maladaptive than positive memories. But these results suggest that people's willingness to erase their memories is more likely driven by the functions the memories serve than by the valence itself.

Another possible explanation for subjects' reluctance to erase their negative memories is that they were wary of the general consequences of erasing a memory. For example, we know that many people believe that changing people's memories in therapy might have unintended negative consequences, and it is possible that some subjects decided not to erase their memory for this reason (Nash, Berkowitz, & Roche, 2016). But this explanation cannot fully account for our results. Based on this explanation alone, we would expect to see similar reluctance across all memories, regardless of function or valence. But we did not see that. Instead, we saw that subjects' willingness to erase a memory was related to the functions that memory serves, and also that subjects were more willing overall to erase negative memories than positive ones. Therefore, our results do not support this counter-explanation.

Summary

Taken together, this experiment provides evidence that negative memories serve functions in a mix of adaptive and maladaptive ways, and that positive memories are predominantly adaptive. Furthermore, the results show that many people value even their most negative memories, perhaps because they believe the adaptive benefits of

these memories outweighs their maladaptive effects.

In this experiment, though, each subject provided only one memory—either their most positive or most negative memory. If people really are weighing up the adaptive and maladaptive functions of a memory when deciding how much they value keeping that memory around, we should expect that, within any one person's memories, the memories they most want to get rid of should be the ones that are most maladaptive. By contrast, the ones they most want to hold on to should be the ones that are most adaptive. Furthermore, this pattern should hold true regardless of the valence of the memory. We addressed this possibility in Experiment 2.

Experiment 2

In Experiment 2, we asked subjects to provide either their five most negative memories or their five most positive memories. Then, we asked them to pick from these five memories the one they would be most likely to erase, and the one they would be least likely to erase. To further understand the extent to which people value their positive and negative memories, we asked a separate group of subjects to pick from their five nominated memories the one they most want to save forever, and the one they least want to save. We hypothesised that people want to hold on to adaptive memories and get rid of maladaptive memories. If so, subjects' "most likely to erase" memories should be more maladaptive than their "least likely to erase" memories, and also less adaptive. Conversely, subjects' "most likely to save" memories should be less maladaptive and more adaptive than their "least likely to save" memories. Furthermore, these patterns should hold true for the subjects who provided their most positive memories and also those who provided their most negative memories.

Method

Subjects

We recruited workers from the United States and Canada on Amazon's Mechanical Turk platform through TurkPrime (Litman, et al., 2017).[4] Subjects participated in exchange for $0.70 Amazon credit. We aimed to collect data until 400 subjects had completed the survey. Because of the way Mechanical Turk interacts with Qualtrics, 425 subjects completed the survey. Based on our pre-registered criteria, we excluded 12 subjects who did not provide autobiographical memories. We also excluded a further 9 subjects who selected the same memory as their "most likely" and "least likely" memory. The final dataset contained 404 subjects ($M_{age} = 39.25$, $SD = 14.10$), 142 of whom identified as men, 259 as women, and 3 as neither man nor woman.

Design

We employed a 2 x 2 x 2 mixed design with Memory Valence (positive, negative), and Instructions (erase, save) as between-subjects factors and Memory Choice (most likely, least likely) as a within-subjects factor.

Procedure

This experiment was approved by the University of Waikato's School of Psychology Research and Ethics Committee under delegated authority of the University's Human Research Ethics Committee. We conducted this experiment in accordance with the World Medical Association Declaration of Helsinki.

The procedure for this experiment is displayed in Figure 2. First, subjects completed basic demographics. As in Experiment 1, we told subjects we were interested

in people's memories for specific events that took place within 24 hours at a specific time and place that they personally experienced. Then, we asked some subjects to provide their five most negative memories, and other subjects to provide their five most positive memories. Then, using the same instructions as Experiment 1, we told half of the subjects to suppose they could erase one memory. We then asked these subjects to select, from the five memories they had just described, the memory they would be most likely to erase and the one they would be least likely to erase. We told the other half of the subjects to imagine they could "save" a memory—meaning they would always be able to bring to mind the experience, as well as the images and feelings associated with it, even if they lost their memory for all other experiences (see the Supplemental Materials for the full instructions). We asked these subjects to select from their five memories the memory they would be most likely to save and the one they would be least likely to save. We counterbalanced the order of these selections so that some subjects selected their "most likely" memory first and others selected their "least likely" memory first.

After making both their selections, subjects rated (in counterbalanced order) their "most likely to erase[save]" and "least likely to erase[save]" memories on a series of items. First, as a manipulation check, subjects rated the item "If you could actually erase[save] this memory, how likely would you be to do that?" on a scale from 1 (not at all) to 7 (to a very high degree). Next, subjects rated the helpful and hurtful functions of the memory using the same items as in Experiment 1 (see Table 1 for the full list of these function items). Then, subjects rated the valence of their memory on the same two items used in Experiment 1, and reported their age at the time of the event. Finally, we asked subjects to make a yes or no decision about whether they would erase[save] the

memory. Subjects completed all the ratings about one memory before rating the other memory.

Results & Discussion

Before turning to our main analyses, we first examined subjects' descriptions and checked that our manipulations were successful.

Descriptives & manipulation checks

Subjects' negative memories took place at a mean age of 24.81 years (SD = 13.19, range: 2-70). In the mean, these memories took place 14.49 years ago (SD = 13.27). The descriptions were again fairly short (M_{words} = 14.57, SD = 15.78, range: 1-100)[2]. As expected, subjects rated their negative memories as highly negative ($M_{negativity}$ = 5.27, SD = 1.90, $M_{positivity}$ = 2.08, SD = 1.65). Examples of negative memories subjects described included being cheated on and the death of a parent.

Subjects' positive memories took place at a mean age of 26.32 years (SD = 13.75, range 2-89). In the mean, these memories took place 12.88 years ago (SD = 13.10). The descriptions were fairly short (M_{words}= 16.13, SD = 17.01, Range = 1-103). As expected, subjects rated their positive memories as highly positive ($M_{positivity}$ = 5.83, SD = 1.59; $M_{negativity}$ = 1.79, SD = 1.53). Examples of positive memories included graduating college and the birth of a child.

Next, we checked that subjects rated that they would be more likely to erase their "most likely to erase" memories than their "least likely to erase" memories. They did ($M_{mostlikely}$ = 3.93, $M_{leastlikely}$ = 2.15, M_{diff} = 1.78, [1.46, 2.10]). Likewise, subjects who were asked about saving their memories rated that they were more likely to save their "most likely to save" memories than their "least likely to save" memories

($M_{mostlikely}$ = 5.23, $M_{leastlikely}$ = 3.20, M_{diff} = 2.02, [1.72, 2.33]; See Supplemental materials for a breakdown by valence). These results suggest our manipulations were successful.

Adaptive and Maladaptive function ratings

We now turn to our main research question: to what extent do people's memories serve functions in ways that are adaptive and maladaptive?

Negative memories. First considering subjects' negative memories, we found a pattern that is consistent with Experiment 1: people's negative memories tended to serve functions in a mixture of adaptive and maladaptive ways. As Figure 3 shows, however, the precise mixture of functions varied across memories. More specifically, the left side of the top panel of Figure 3 shows that subjects' "most likely to erase" negative memories tended to be more hurtful than helpful (M_{diff} = 0.93 [0.46, 1.40]) whereas their "least likely to erase" negative memories tended to be more helpful than hurtful (M_{diff} = 1.09 [0.64, 1.54]). Comparing these two sets of memories, we found that subjects' "most likely to erase" memories were less helpful than their "least likely to erase" negative memories (M_{diff} = 1.13, [0.82, 1.44]) and also more hurtful (M_{diff} = 0.89, [0.54, 1.23]).

The results from subjects who were asked about saving their memories mirror these results almost exactly, as the left side of the bottom panel of Figure 3 shows. Subjects' "most likely to save" memories tended to be more helpful than hurtful (M_{diff} = 0.95 [0.53, 1.37]), whereas subjects' "least likely to save memories" tended to be more hurtful than helpful (M_{diff} = 0.89 [0.50, 1.27]). Comparing the two sets of memories, we found that subjects' "most likely to save" negative memories were more helpful than

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their "least likely to save" negative memories (M_{diff} = 1.18, [0.86, 1.49]), and less

hurtful (M_{diff} = 0.66, [0.37, 0.95]).

Together, these results provide further support for the idea that negative

memories serve functions in ways that have both adaptive and maladaptive effects.

These results extend those Experiment 1 by suggesting that although negative memories

are often more adaptive than maladaptive, it is also common for them to be more

maladaptive than adaptive (see the Supplemental Materials for a breakdown by each

individual function). Furthermore, the results show that in addition to being unwilling to

erase adaptive negative memories, people also desire to preserve those memories as

they are.

But how willing overall were people to want to erase or save their memories? In

Experiment 1, only a minority of people reported they would erase their most negative

memory. But in this experiment, there were some memories that subjects commonly did

not want to hold on to—most subjects (75%) said they would erase their "most likely to

erase" negative memory, and few subjects (12%) said they would save their "least likely

to save" negative memory. Crucially, these memories tended to be ones that were more

hurtful than helpful. By contrast, subjects tended to want to hold on to the memories

that were more helpful than hurtful—only a minority of subjects (32%) said they would

erase their "least likely to erase" negative memory, and the majority of subjects (60%)

said they would save their "most likely to save" negative memory.

Positive memories. In contrast to subjects' negative memories, but consistent with

Experiment 1, subjects' positive memories tended to be predominantly adaptive. More

specifically, the right side of the top panel of Figure 3 shows that subjects' most likely

to erase positive memories were much more helpful than hurtful (M_{diff} = 2.02 [1.59,

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2.45]), as were their least likely to erase positive memories (M_{diff} = 3.71 [3.28, 4.13]). Comparing the two sets of memories, we found that subjects' "most likely to erase" positive memories were less helpful than their "least likely to erase" positive memories (M_{diff} = 1.24, [0.91, 1.57]) and more hurtful (M_{diff} = 0.44, [0.18, 0.70]).

Likewise, as the right side of the bottom panel of Figure 3 shows, subjects' most likely to save positive memories were much more helpful than hurtful (M_{diff} = 3.80 [3.36, 4.24]), as were their least likely to save negative memories (M_{diff} = 2.37 [1.87, 2.87]). Once again, subjects' "most likely to save" positive memories were more helpful than their "least likely to save" positive memories (M_{diff} = 1.10, [0.74, 1.45]), and less hurtful (M_{diff} = 0.34, [0.09, 0.59]).

These results provide further support for the idea that positive memories tend to be primarily adaptive. Furthermore, across both positive and negative memories, people want to hold on to memories that serve adaptive functions and get rid of memories that serve maladaptive functions. Unsurprisingly, few subjects wanted to erase their positive memories—only 17% said they would erase their "most likely to erase" positive memory, and 6% said they would erase their "least likely to save" positive memory. By contrast, most subjects wanted to save their positive memories—97% said they would save their "most likely to save" positive memory, and 78% said they would save their "least likely to save" positive memory. From these two experiments it is clear that most people value holding onto their positive memories, perhaps because these memories are almost exclusively adaptive.

Predicting willingness to save or erase

As in Experiment 1, we ran exploratory logistic regressions to test the possibility that

negative valence, rather than adaptive or maladaptive function, was really driving people's choices to save or erase their negative memories. Because we asked each subject to rate two memories, we conducted multi-level models with helpful function, hurtful function, and valence predicting people's decisions about whether to save[erase] their two memories.

Recall that some subjects were asked about saving their memories, and others were asked about erasing them. Therefore, we conducted separate regressions for subjects in those two conditions. The model predicting subjects' decisions about whether to erase their memories produced results that were largely consistent with Experiment 1. More specifically, helpful function and helpful function both strongly predicted subjects' decision to erase their memories. The more hurtful a memory was, the more likely subjects were to say "yes" to erasing the memory ($OR = 3.03$ [1.61, 5.70]), and the more helpful a memory was, the less likely they were to say "yes" to erasing it ($OR = 0.32$ [0.16, 0.64]). Valence was a trivial and non-significant predictor of subjects' decisions to erase their memories ($OR = 1.07$ [0.77, 1.48]). These results suggest that people's willingness to erase their memories is more likely driven by the functions the memories serve than by the valence of the memory itself—consistent with Experiment 1.

The model predicting subjects' decisions about whether to save their memories produced a somewhat different pattern. More specifically, helpful function was the strongest and only significant predictor of people's decision to save their memory. The more helpful a memory was, the more likely subjects were to say "yes" to saving it ($OR = 2.31$ [1.65, 3.23]). Unlike the model predicting subjects' decisions to erase their memories, there was no strong evidence that hurtful function predicted people's

decisions to save their memories ($OR = 0.88$ [0.68, 1.13]). Perhaps the "erase" framing drew subjects' attention more to maladaptive functions, whereas the "save" framing drew subjects' attention more to the adaptive functions of the memory. Regarding valence, the more negative a memory was, the less likely subjects were to say "yes" to saving it, but this effect was not significant and size of this effect was plausibly trivial ($OR = 0.84$ [0.69, 1.02]).

Overall, these findings suggest that people want to erase maladaptive memories and save adaptive memories. Furthermore, valence did not account for these relationships.

Summary

Taken together, the results from Experiment 2 provide further evidence that people's memories serve functions in a mixture of adaptive and maladaptive ways. Moreover, the results suggest that people want to get rid of memories that are maladaptive and hold on to memories that are adaptive.

General Discussion

Across two experiments and 814 subjects, we found that people rated their negative memories as moderately adaptive, but also moderately maladaptive. By contrast, people rated their positive memories as predominantly adaptive. Furthermore, we found evidence that the maladaptive effects of a memory are distinct from its valence. We also found that people wanted to hold on to memories that serve functions in adaptive ways and get rid of memories that serve functions in maladaptive ways. Considered together, these findings get us a step closer to the goal of identifying the adaptive and maladaptive effects of people's autobiographical memories.

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The experiments documented here have implications for the literature on the functions of autobiographical memories. Our findings extend research showing that some uses of memory—such as bitterness revival and rumination—can be maladaptive. More specifically, these findings demonstrate that the three theorised functions of autobiographical memory can sometimes produce maladaptive outcomes. Why, though, do we have a memory system that often carries with it these maladaptive effects? One possibility is that these effects are a by-product of the same processes that allow autobiographical memories to serve adaptive functions. After all, it is often the case that maladaptive outcomes can result from generally adaptive processes (e.g., Bruce 1985). For example, although fear conditioning regularly helps people avoid potential threats, in extreme cases it can lead to phobias that cripple people's ability to function (Seligman, 1971). This idea fits with the ecological literature, which suggests that no process or trait is inherently adaptive (Bruce, 1985). Instead, the adaptiveness of a trait depends on the context in which the trait is expressed. Similar ideas have been proposed for false memories—that they are the maladaptive by-product of having a memory system that is flexible enough to update and correct mistakes (Newman & Lindsay, 2009).

Given that we found evidence of these maladaptive effects only in people's most negative memories, it seems likely that the majority of autobiographical memories tend to be more adaptive than maladaptive. But to fully understand the relative adaptive and maladaptive contributions of autobiographical memories, future research should continue to investigate other ways in which autobiographical memories can be maladaptive. For example, although we found little evidence that positive memories are

maladaptive, positive memories that produce a sense of nostalgia, or which lead people to beome overconfident might also have maladaptive effects.

In investigating people's desire to preserve their memories, these experiments also contribute to our understanding of people's attitudes towards their memories. Our results are consistent with other work suggesting people often value their negative memories—people regularly keep photos and mementos that bring to mind negative experiences, and report they would not take a drug that would dampen a negative memory, even if doing so might reduce the likelihood of developing PTSD (Newman, Berkowitz, Nelson, Garry, & Loftus, 2011; Petrelli & Whittaker 2008). Nonetheless, some of our subjects reported they would want to rid themselves of negative memories—especially memories that were highly maladaptive. Given the recent efforts to identify drugs that might alter the content of negative memories, it is important to consider both the adaptive and maladaptive effects these memories can have (Brunet et al., 2008; Pitman et al., 2002). Unless these drugs can reduce the maladaptive effects of negative memories while leaving the adaptive functions intact, it might not always be wise to use them (Bluck, 2017).

Our results also highlight the overlap between the literature on autobiographical memory and the literature on clinical cognition. More specifically, the posttraumatic growth literature suggests people who experience a traumatic event often believe they have grown as a result of the experience (Schuettler & Boals, 2011; Tedeschi & Calhoun, 2004). For example, people often report a traumatic experience changed their life path, taught them how strong they are, or increased their closeness with others. Such reports are remarkably similar to the adaptive functions we subjects in our experiments commonly reported, and that have been discussed across the autobiographical memory

literature (Bauer, McAdams, & Pals, 2008; Bluck et al., 2005; Pillemer, 1992; McAdams et al., 2001). Furthermore, people often report post-traumatic growth even if a traumatic experience also produced maladaptive consequences such as post-traumatic stress symptoms. These reports fit with our finding that any given memory can serve functions in both adaptive and maladaptive ways.

We do not know, however, the extent to which order effects contributed to the relationships between the functions and people's willingness to erase their memories. In Experiment 1, subjects completed the function and valence ratings before rating their willingness to erase that memory. It is possible that rating the functions first encouraged subjects to consider those functions when rating their willingness to erase that memory. In turn, subjects might have adjusted their willingness based on their function ratings in a way they normally would not have. In Experiment 2, we attempted to address this possibility by reversing the order and first asking people to decide how willing they would be to erase the memory before rating valence and function. That the findings of the two experiments produced similar results provides some evidence against this possibility. Furthermore, if order effects were driving these relationships, it is unclear why we would not also see similar relationships between valence and people's willingness to erase their memories. Therefore, it seems unlikely that order effects can explain the results of these two experiments.

There are, however, at least three limitations to our findings. First, we measured the adaptive and maladaptive forms of each function with only a single, broad item. In this, a first attempt to separate adaptive and maladaptive functions, we operationalized adaptive as "helpful" and maladaptive as "hurtful." But it is possible that when subjects rated the hurtful ways they use their memories, they were referring to ways in which the

memories were emotionally painful, but ultimately adaptive. If so, we might expect that negative memories rated as highly hurtful might also be the ones rated as highly helpful. But we found instead that subjects' ratings of hurtful functions were negatively correlated with their ratings of helpful functions. Nonetheless, it is important that future research develops more robust measures of the ways in which memories are maladaptive.

A second limitation is that we asked people for events that took place within 24 hours, and at a specific time and place. There is evidence, however, that recurring events and events that take place over an extended time can serve functions differently to specific events (Waters, Bauer, & Fivush, 2014). To establish a broad understanding of how autobiographical memories serve functions in ways that are adaptive and maladaptive, future work should investigate the relative mix of functions served by these different types of memories.

A third limitation is that our measures of function rely on subjects' self-reports. In this way, our work here suffers from the same limitation that plagues the field as a whole: we do not know the degree to which the functions people reported accurately reflect the functions their memories actually serve. We are, of course, not the first to raise this limitation (Hyman & Faries, 1992). If we are to move forward as a field, it is worth thinking about ways to incorporate behavioural measures into studies of autobiographical memory functions.

Taken together, these two experiments provide evidence that memories can serve directive, self, and social functions in ways that are maladaptive. In doing so, our findings stress the importance of taking a broader view of functions that distinguishes between their adaptive and maladaptive forms—especially when investigating negative

memories. If we, as a field, conflate adaptive and maladaptive use of memory, or focus primarily on ways in which people's memories are adaptive, we risk inflating the reported frequency of adaptive functions. More broadly, such an approach would hinder our efforts to fully understand the ways in which people's memories affect their behaviour, identity, and relationships.

Author Notes

1. This exclusion rate is lower than that of many other published studies run on Mechanical Turk, including those from our own laboratory. This low rate could be due to the stringent criteria we used for this study, which required at least a 99% approval rating.
2. We did not exclude subjects on the basis of the length of their description because some subjects provided short descriptions (e.g. "getting married") that appeared to be genuine autobiographical memories.
3. The reason we employed a logistic regression with subjects' dichotomous choice as the dependent measure is that the bimodal distribution of subjects' ratings of their likelihood to erase the memory made those data inappropriate for linear regression. In addition, because there was very little variance in the maladaptive functions of subjects' positive memories (which were at floor) we restricted these analyses to negative memories only.
4. The data for Experiment 2 were collected before the data for Experiment 1.

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Disclosure statement

The authors report no conflicts of interest.

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Table 1. Full list of items for Experiments 1 and 2.

Function

This memory guides my thinking and behavior in ways that help me

This memory guides my thinking and behavior in ways that hurt me

This memory tells me something about my identity in ways that help me

This memory tells me something about my identity in ways that hurt me

I share this memory with other people in ways that help me

I share this memory with other people in ways that hurt me

This memory gives me a sense of belonging with other people

This memory gives me a sense of disconnection from other people

Valence

The feelings I experience as I recall the event are extremely positive

The feelings I experience as I recall the event are extremely negative

Willingness to erase/save

If you could actually erase[save] this memory, how likely would you be to
 do that? (1 = not at all likely, 7 = extremely likely)

If you could actually erase[save] this memory, would you? (Yes/No)

Age of event

How old were you when this event took place? Please give your age at the
 time estimated in years; type in the number, e.g., 7

Centrality

This memory is significant for my life because it imparts an important
 message for me or represents an anchor, critical juncture, or a turning
 point (1 = not at all, 7 = completely)

Note. Function and Valence items all rated from 1 (not at all) to 7 (to a very
 high degree). Items adapted from Rasmussen and Berntsen (2009), and
 Rubin, Schrauf, and Greenberg (2003).
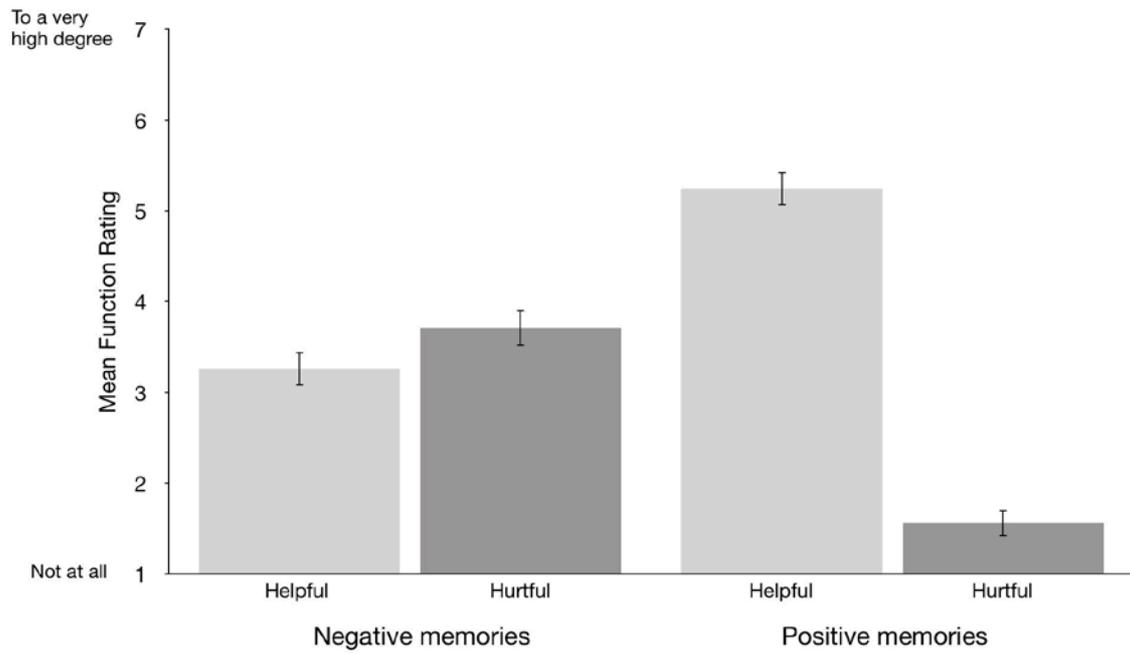
Figure 1. Mean helpful and hurtful function ratings for subjects' positive and negative memories. Error bars represent 95% confidence intervals of the cell means.
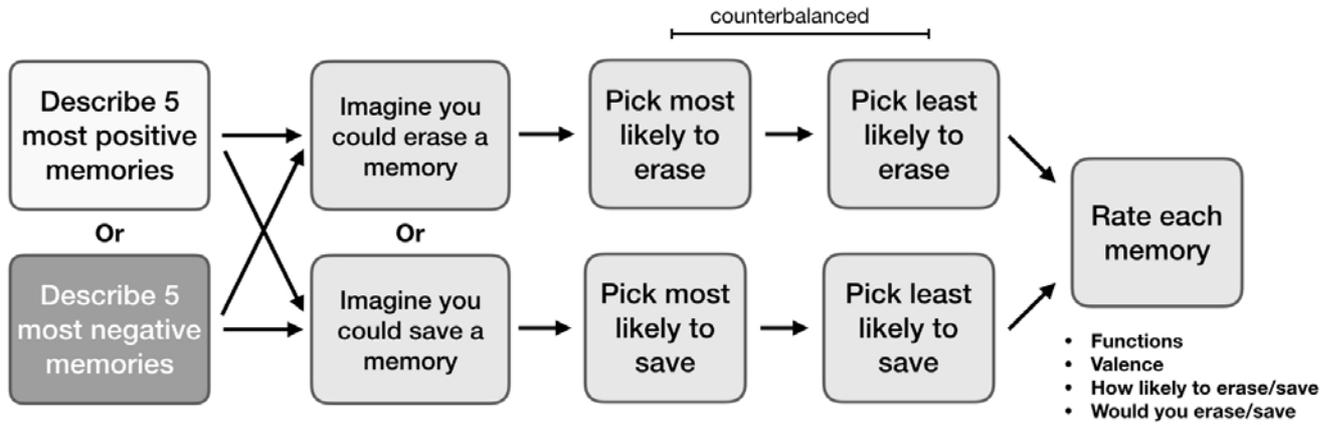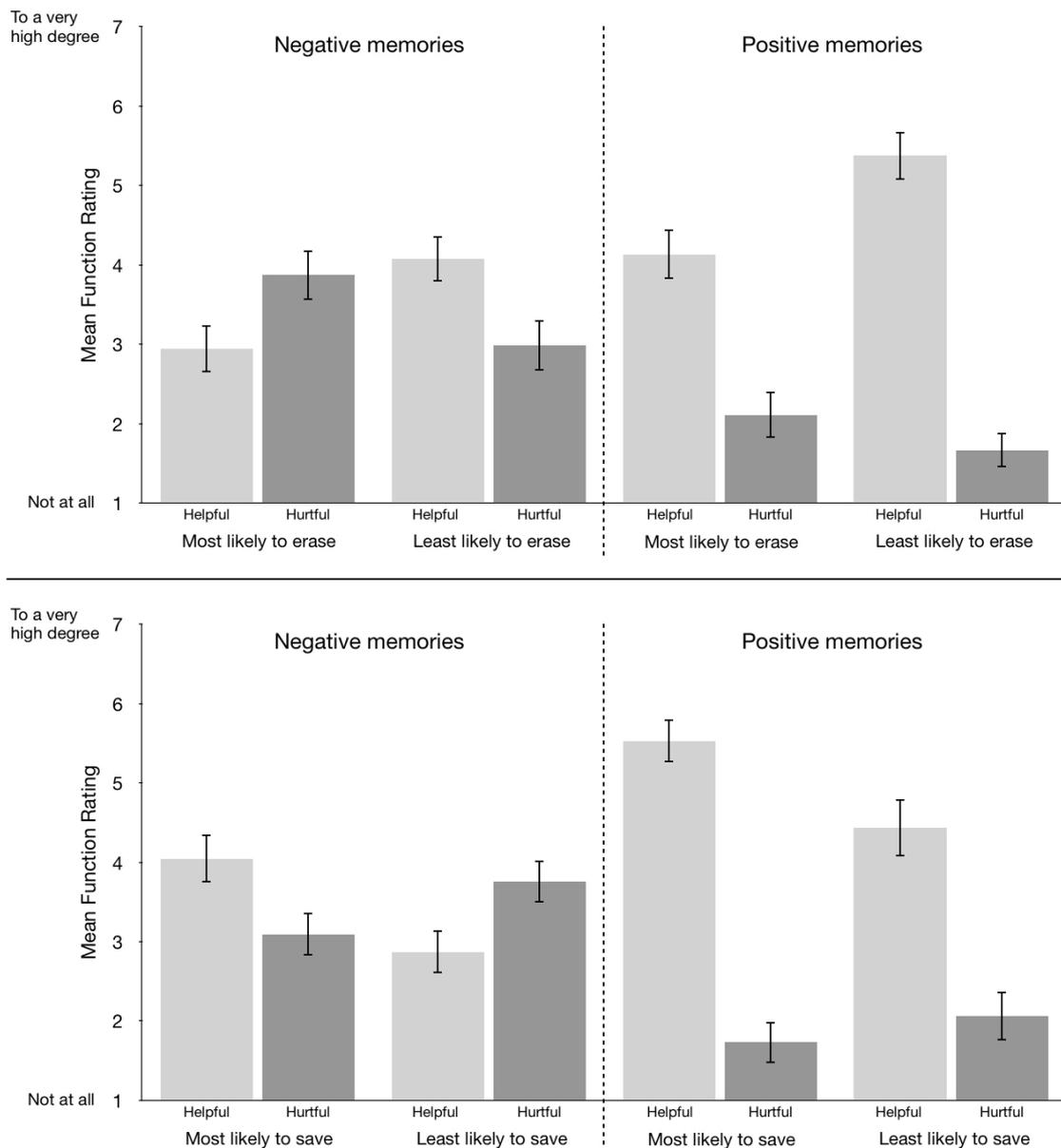
Figure 2. Diagram of the method for Experiment 2.

Figure 3. The top panel displays the mean function ratings of subjects who selected the memory they would be most likely to erase and the one they would be least likely to erase. The bottom panel displays the mean function ratings of subjects who selected the memory they would be most likely to save and the one they would be least likely to save. The left-hand side of each panel displays subjects who provided their five most negative memories, while the right-hand side displays subjects who provided their five most positive memories. Light grey bars represent mean helpful function ratings, dark grey bars represent mean hurtful function ratings. Error bars represent 95% confidence intervals of the cell means.