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Remembering All That and Then Some: Recollection of Autobiographical Memories after a One-Year Delay

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Abstract

We previously showed that repeated retrievals of remote autobiographical memories over the course of one month led to an overall increase in reported detail (Nadel, Campbell & Ryan, 2007). The current study examined the retrieval of those same memories one year later in order to determine whether the level of detail remained stable or whether the memories returned to their original state. Participants reported even more details than they had recalled at least one year earlier, including new details that were reported for the first time. This finding was consistent across both multiple and single retrieval conditions suggesting that the critical factor leading to the increase in recall was the passage of time. These findings provide evidence for long-term effects of repeated retrieval on memory content.

INTRODUCTION

What happens to memories for autobiographical events as time passes and stories are told and retold to family and friends? Despite the importance of this question to the field of memory and to our everyday lives, surprisingly few empirical studies have addressed this fundamental issue. The existing literature has focused almost exclusively on the effect of retrieval on newly acquired information such as word lists, pictures, or stories, but not autobiographical memories. The few studies that exist report mixed results for memories that are repeatedly recollected and retold. For example, Bartlett's observational study of the War of the Ghosts (1932) suggested that the passage of time results in a loss of detail as memories become simplified and distorted, while retaining the core elements, or gist, of the story. Wynn and Logie (1998) also found that although gist persisted across time and over repeated retrievals, new peripheral details were added, potentially for the listener's sake, as first-year students recalled an orientation lecture. In contrast, Gauld and Stephenson (1967) argued that Bartlett's open-ended interview style led to increased errors of recollection, and found that instructions emphasizing strict accuracy resulted in reduced error rates even when using the same test materials as Bartlett.

More recently, in a controlled replication, Bergman and Roediger (1999) reproduced Bartlett's original results, showing that participants forgot details of the folktale over delays of fifteen minutes, one week, and six months. Participants' memories also included the same rationalizations and distortions observed by Bartlett, which increased with lengthening retention intervals and, contrary to Gauld and Stephenson (1967), did not depend on whether lenient or strict instructions were provided to participants. These results would suggest that memories are indeed simplified, modified, and generally forgotten over time.

A very different view of memory over time and repetition comes from the literature on hypermnesia. Even earlier than Bartlett, Ballard (1913, reviewed in Payne, 1987) reported that children could recall lines of poetry on subsequent memory tests that they could not recall on an initial test. Much later, Erdelyi and Becker (1974) demonstrated that recall for pictures increased over the course of three memory tests with delays, and coined the term hypermnesia to refer to the phenomenon of increased recollection as a function of retrieval practice. Other studies of hypermnesia have resulted in a similar outcome where participants' recall improved for both verbal and visual materials over repeated test sessions (Klein, Loftus, & Kihlstrom, 1989; Payne & Roediger, 1987; Roediger & Thorpe, 1978; see Erdelyi, 2010, for a recent review).

Most hypermnesia studies employ lists of words, sets of pictures, or brief stories as the to-be-remembered materials that are acquired in a single session. Although hypermnesia has been discussed in the context of research relevant to autobiographical memory, including eyewitness testimony (Turtle & Yuille, 1994) and flashbulb memories (Coluccia, Bianco, & Brandimonte, 2006), few studies have investigated the effect of repeated retrievals on episodic memories for life events. In one such study, Bluck and colleagues (Bluck, Levine, & Laulhere, 1999) interviewed participants eight months after the television airing of the O.J. Simpson verdict. Participants were required to recall the details of the event three times over the course of a single hour. Bluck et al. (1999) reported a significant increase in memory for the details of the event across the three closely spaced retrievals.

Many factors contribute to determining which stimuli are better recalled and which are eventually forgotten over time. Wheeler and Roediger (1992) set out to determine which experimental procedures lead to forgetting as in Bartlett's paradigm and which lead to the increase in recall as in Ballard's experiment. They found that the type of material used plays less of a role than the length of the inter-test interval. They found improvement in recall between tests when intervals were short (five or eight minutes), and forgetting occurred when intervals were long (one week to one month). Additional factors, such as personal relevance, salience, emotionality, and level of associated imagery may all be factors that increase the ability to remember certain material.

In the current study we are interested in what happens to rich, personally-relevant, and emotionally-charged autobiographical events as they are recalled and retold over weeks, months, or even years? Do they lose detail and become gist-like, as Bartlett (1932) and others would suggest? Or does the repeated retrieval and retelling of these stories result in richer, more detailed recollections, as suggested by the studies of hypermnesia?

We initially addressed this question in a study that involved repeated recollections of autobiographical memories over the course of a 30 day period (Nadel, Campbell, & Ryan, 2007). Three different retrieval conditions enabled us to observe differences in what participants recalled after the passage of time and repeated retrievals. Memories that were included in the original analysis were rich, highly-detailed, personally-relevant life events from at least two years ago but widely distributed throughout all life stages, and on average were rated as very emotional. In a *Remote Retrieval* condition, 12 memories were recalled twice, 30 days apart on Days 1 and 30. In a *Recent Retrieval* condition, 12 memories were recalled twice, two days apart on Days 28 and 30. In a *Multiple Retrieval* condition, 12 memories were recalled six times at intervals of approximately one week on Days 1, 7, 14, 21, 28, and 30. On Day 30, participants in all conditions recalled all 36 memories while undergoing fMRI scanning; these results have already been reported (Nadel et al., 2007) and will not be addressed here.

On Day 30 all memories were retrieved silently in the scanner, hence behavioral data are not available for analysis from this retrieval session. As a result, behavioral changes seen in the Multiple Retrieval condition were the only ones we could observe in the original study. We reported a significant increase in memory length and internal and external details, or *total* memory details, across the five retrieval sessions. There was also a linear increase across sessions in the repetition of phrases used to describe each memory, a measure we refer to as “phrase consistency”, such that details mentioned during one retrieval session were more likely to be repeated during a subsequent retrieval session. This pattern suggested that as a memory was being recalled, participants recruited additional details to what became a consistent story, or “episodic narrative”. The behavioral results for the Multiple Retrieval condition are depicted in Figure 1.

In the current study, eight middle-aged participants who had taken part in the original study (Nadel, et al., 2007) agreed to return to the laboratory. These participants were unaware, at the conclusion of the previous study, that we would call them over a year later. Upon their return, participants recalled all 36 autobiographical memories that were recalled in the context of the previous experiment approximately one and a half years earlier. We compared these results (time 2) with those from the original study (time 1) for all three conditions. In this way we explore the influence of the passage of a long delay, over one year, after two or six retrieval sessions over the course of one month. According to Multiple Trace Theory, retrieval of a memory initiates a process of reconsolidation, strengthening the existing memory trace and possibly incorporating new information. We expect to see a further increase or stabilization of the level of detail recalled for the Multiple Retrieval memories as a result of not only repeated exposure to the material but also the accompanied process of reconsolidation. Since the single retrieval conditions, Remote and Recent, involved only two prior retrieval sessions, the effects of reconsolidation in these conditions should be smaller than those observed in the Multiple Retrieval condition.

METHODS

Participants

Data from eight of the original 12 participants are reported here (ages 47–64, mean age 57.4; mean years of education, 16.2; range 12–20; 5 female, 2 male). Participants who agreed to return for the experiment were initially unaware that the current study was related to the earlier study. Three of the original 12 participants were unavailable for the follow-up experiment. One other participant completed the study protocol but did not adequately follow instructions; as a result, this participant’s data were excluded from the current analyses. Participants received monetary compensation for their participation.

Materials

In the original study, an extended version of the list of common life events developed by Levine et al. (2002) was used to generate episodic memories from participants during the initial retrieval session. Participants were instructed to recall only unique events that had occurred more than two years ago and that took place in a specific place and time. They were instructed to visualize the details of the event, playing it out as if it were a scene in a movie, while verbally describing all of the details that they could remember including what happened, who was there, where they were, what they were feeling, and the time of day. The experimenter then created a specific memory cue for each memory, such as “Mary’s 40th birthday party”, that was used for cued recall during subsequent retrieval sessions. The same thirty-six memory cues derived during the original study were used for each participant in the current experiment.

Procedures

Participants were interviewed approximately a year and a half after completion of the original study (mean 1.4 years, range 1.2–1.9 years). An interviewer who was not involved in the previous study conducted six interviews in-person, and one participant's interview was conducted over the phone. The interviewer was instructed not to comment or converse during the recollections, acting only as an engaged listener. Participants were instructed that they were going to discuss the same memories as during the former study, and they were given the exact same retrieval instructions as in the previous study. They were encouraged to retrieve all the details they could remember, even if they had discussed the same details in the past. In addition, they were instructed to include any new information that came to mind that they had not previously discussed. Their recollections were tape recorded and later transcribed for analysis.

Following recollection of each event, participants were asked to rate the memory on several scales, including the importance of the event at the time that it occurred, the current importance of the memory, the emotionality of the event at the time it occurred, the current emotionality of the memory, how vividly the memory was recalled, and their energy level or arousal at the time of the event. Ratings were made on a 1–5 scale, respectively representing not at all (1), somewhat (2), moderately (3), very (4), or extremely (5). Participants were also asked to rate how positive or negative the event was at the time that it occurred using the following scale: very negative (–3), somewhat negative (–1), neutral (0), somewhat positive (+1), and very positive (+3). Participants had also rated their memories on these same scales following their initial recollection during the original study.

Script analysis

Three types of details were identified using methods similar to Levine et al. (2002). Internal details occurred at the time of the event itself. For example, “this was during the summer before I turned sixteen,” describes an internal detail for the memory “taking your first plane flight”, as it identifies the time of the event. External details provided context for the memory or general knowledge that was not unique to the event, occurred outside of the time window of the event, or provided a judgment about the event. For example, “I had gone on train rides in the past, to the Grand Canyon and such”, describes an external detail for the memory “going on a train ride”. Editorial details were statements that reflected uncertainty, such as, “I think this was...” or “Now that I think about it, it had to have been...”. Two raters performed the detail analyses, followed a set of fixed rules, and obtained an inter-rater reliability on each of the three detail types above 85%. Any discrepancies were evaluated and adjudicated by one of the authors (J. Campbell). The total number of words spoken while the participant described each event was obtained using the word count option in Microsoft Word.

RESULTS

Details and Word Counts

Contrary to the findings of Bartlett (1932) and others (e.g., Bergman & Roediger, 1999) that forgetting occurs over time and with repeated retrievals, detail counts for all three of the original memory conditions increased over a one and a half year delay. The number of details recalled for the initial retrieval session and the follow-up session for each condition were compared (Day 1 versus follow-up for Remote and Multiple, Day 28 versus follow-up for Recent). For the Multiple Retrieval condition, we also compared the details recalled during the fifth and final behavioral retrieval session of the original study on Day 28 with the follow-up session. These results are displayed in Figure 2.

Due to the variability in the length of memories across participants, details were analyzed at the item level rather than in terms of the mean detail count per participant. Four separate 3×2 repeated measures analyses of variance (ANOVA) comparing retrieval condition (Remote, Recent, and Multiple) and time (initial and follow-up) were conducted to determine if word count, internal, external, and editorial details differed between the initial and follow-up retrieval sessions. In every instance participants were able to remember the same 36 memories via cued-recall. Word count generally increased between initial and follow-up, indicated by a main effect of time, $F(1, 95) = 59.64, p < .001$, with no interaction effect. Follow-up paired t-tests revealed significant differences in mean word count between initial and follow-up for Remote [$t(1, 95) = 2.88, p < .005$], Recent [$t(1, 95) = 5.01, p < .001$], and Multiple [$t(1, 95) = 4.77, p < .0001$] conditions. External details also increased across time for all three retrieval conditions, indicated by a main effect of time $F(1, 95) = 92.95, p < .001$. Paired follow-up t-tests revealed significant differences in mean external details between initial and follow-up for Remote Retrieval memories [$t(1, 95) = 5.68, p < .001$], for Recent Retrieval memories [$t(1, 95) = 6.21, p < .001$], and for Multiple Retrieval memories [$t(1, 95) = 4.48, p < .0001$]. Editorial details increased across time for all three retrieval conditions, indicated by a main effect of time, $F(1, 95) = 57.78, p < .001$. Paired follow-up t-tests revealed significant differences in mean editorial details between initial and follow-up for Remote [$t(1, 95) = 4.04, p < .001$], Recent [$t(1, 95) = 8.26, p < .001$], and Multiple [$t(1, 95) = 5.21, p < .0001$]. Internal details also generally increased over time, $F(1, 95) = 14.87, p < .001$, but this effect was moderated by an interaction between time and retrieval condition $F(2, 94) = 4.66, p < .01$. Paired follow-up t-tests for internal details revealed significant differences between initial and follow-up for the Recent condition, [$t(1, 95) = 3.95, p < .0001$], and the Multiple condition [$t(1, 95) = 3.30, p < .001$], but not the Remote condition, ns.

Ratings

Rating scores from the current study were compared to those from the original study. Mean rating scores for the three memory conditions are shown in Table 3. Interestingly, although the reported details of memories generally increased over time, the ratings of current emotionality, importance then and now, vividness, and arousal all declined significantly, regardless of the original retrieval condition, with the exception of the event at the time that it occurred. Repeated measure ANOVAs comparing retrieval condition (Remote, Recent, and Multiple) and time (initial and follow-up) were conducted on each rating question. Ratings that declined significantly, indicated by main effects of time, included importance at the time the event, $F(1, 93) = 6.88, p < .01$, importance of the event now, $F(1, 93) = 6.13, p < .05$, emotionality of the event now, $F(1, 93) = 12.99, p < .001$, vividness of recollection, $F(1, 93) = 14.13, p < .0001$, and arousal at the time of the event, $F(1, 93) = 5.12, p < .05$. Participants' ratings of how emotional the event was at the time that it occurred did not change significantly with time $F(1, 93) = 1.44, ns$, nor did their ratings for valence, or how positive or negative the event was at the time, $F(1, 93) = 2.62, ns$. No interaction effects between time and retrieval condition approached significance for any rating.

Phrase consistency

In order to assess whether or not the scripts of the memories at follow-up were consistent with previous recollections, a consistency measure was calculated for memories in the Multiple Retrieval condition by identifying the proportion of total details repeated at follow-up that had been retrieved in the original study on either five, four, three, two, or one occasion. For example, the number of details described in the follow-up that had been mentioned five times in the original study was divided by the total number of details that had previously been retrieved five times. The same calculation was made for four, three, two, and one previous repetition.

Results of this analysis suggested that the consistency effect observed across the original study was moderately maintained in the follow-up retrieval session; the greater the number of previous repetitions, the greater the likelihood that the detail was repeated during the follow-up interview. These results are displayed in Table 2.

In addition to repeating previously retrieved details, participants retrieved new details that were not included in their previous recollections during follow-up. As shown in Table 3, 40% of the details reported for memories in the Multiple Retrieval condition after one year had not been reported before.

DISCUSSION

Despite decades of memory research, surprisingly few studies have asked what happens to memories for events that are salient, emotionally-charged, and important to the story of our lives as they are recounted and conveyed to family, friends, and strangers, over months and years. The present study is an attempt to address that question. In contrast to Bartlett (1932), we find that autobiographical memories become more detailed and contextualized as they are retold after a delay of one and a half years, rather than impoverished. New information is added, and many of the details that were present in previous accounts are expanded. Consider, for example, a single detail taken from a memory on Day 1 (see Appendix A for text). Over the course of a single year, what began as a short sentence of seven words becomes a paragraph, four sentences and eighty words in length. The embellishments are an extension of the memory itself, tying it together with information that will bring the significance of the event into current perspective, and framing the event in the bigger picture of the speaker's life. The speaker appears to be creating this episodic narrative for the benefit of the listener, and has become, in effect, an expert storyteller.

We believe these results make sense when viewed in the context of the social nature of memories and story telling. Many researchers have emphasized that memories are told for social benefit -- they build relationships amongst people and provide a foundation for our sense of self (Bluck, Alea, & Habermas, 2005), and the specific role they play over our lifespan changes as our goals and social networks change (Hyman & Faries, 1992; Rubin, 1995). Consider how maladaptive our memory system would be if autobiographical memories became fragmented, devoid of detail, disorganized, and confused over time as evidence from Bartlett (1932) and Bergman and Roediger (1999) would suggest. In contrast the virtues of a memory system that allows people to tell their life stories years later through memories that are complete and salient are clear.

In the context of the present study we cannot assess the accuracy of the memories being described. Accuracy of memories over long delays is often the focus of flashbulb memory studies, where accuracy of later recollections can be assessed by direct comparison to the details of the actual event, either obtained from the individual directly after the event or news reports. In one particular study (Schmolck, Buffalo, and Squire, 2000), participants were asked to recall nine specific details of hearing the O.J. Simpson trial verdict. After 15 months, distortions were relatively uncommon, but after 32 months over 42.9% of the details were major distortions. They found that marked changes in the memory occurred between one and three years after the event. Several other studies (Bohannon and Symons, 1992; Neisser and Harsch, 1992) also reveal a sharp decrease in accuracy after a 32 month delay. However, flashbulb memories may have different characteristics than every day memory.

It is widely accepted and has been demonstrated in many studies (e.g., Loftus, 1974; Neisser, 1981) that episodic memories are susceptible to revision, with the inclusion of

incorrect information or even the development of memories for events that never happened (Ceci, Huffman, Smith, & Loftus, 1994; Loftus & Cahill, 2007). Roediger and his colleagues (Roediger, McDermott, & Goff, 1997) have described these general findings in a review on the paradoxical effects of repeated testing, stating that, “the act of retrieval consolidates the memory and confers easier (and more confident) access later.” This may result in an increase in accurate recollections but could also result in an increase in false information or the creation of false memories. It is likely that the increase in detail we have observed is due to both the accurate addition of internal details (as the hypermnnesia literature would suggest) and inaccurate embellishments (as demonstrated by Loftus and others). It is critical to note that while these additions may be inaccurate they are not necessarily inappropriate, in that they reflect knowledge derived from prior (or subsequent) experiences of a related nature. This process serves to create a rich episodic narrative that is, as Neisser (1981) noted in discussing John Dean’s memory for the Watergate events, not accurate in all detail but quite truthful to what actually happened. Neisser referred to this type of memory as “repisodic”.

The memories described by participants in the present study were already well-established, based on events that were rated as important and emotionally rich, and may have already been described and revisited many times in the past. It is also important to note that memory retrievals were not controlled during the period of over one year between the two experiments. Thus, it is possible that these memories were rehearsed during the year preceding our follow-up retrieval test. However, it is unlikely that all 36 memories were repeated in the intervening year, leading us to conclude that these effects are not merely a result of non-experimental retrievals. In addition, the increase in detail is consistent and stable across the three retrieval conditions, suggesting that this effect is mostly attributable to the passage of time (over one year) and minimally to the number of retrieval repetitions (three in the Remote and Recent conditions and seven in the Multiple condition).

The results are consistent with the ideas of Multiple Trace Theory (MTT; Nadel & Moscovitch, 1997; Ryan et al., 2001; Nadel et al., 2007). By this view, memory retrieval initiates both passive (time-based) and active (retrieval-based) processes. Each retrieval, or reactivation, leads to reconsolidation, incorporating the new context and available new information. That is, according to MTT, retrieving a memory can change it. This new memory trace, that interweaves retrieved aspects of the old memory with new information, suggests several things. First, it predicts the incorporation of new and possibly erroneous information into a retrieved memory trace. Second, it raises the possibility that some of the “new” information is not new at all, but rather reflects knowledge derived from related experiences in the past. As a given memory is recalled and reconsolidated, this new information helps create a consistent episodic narrative that becomes the “true” memory in the future.

It is interesting to note that the memories described by participants were rated differently after the passage of another year regarding current emotionality, importance, and vividness, although participants still rated the memories on average as “very important” and “very emotional” as well as “moderately to very” vivid. Of course, the change in these ratings could reflect a simple regression to the mean, but they might also reflect the notion, suggested in the traumatic memory literature (Leskin et al., 1998), that the telling of an event, coupled with the passage of time, decreases the emotional impact of that event, perhaps a small indication that time indeed heals all wounds. Nonetheless, it is intriguing that as memories expand they also become somewhat less emotional and important. Further research will determine whether these two effects are linked in some way, or independent results of the passage of time.

The influence of repeated recall has never been assessed using extended, spaced retrievals of remote, autobiographical memories, although this pattern of retrieval may most closely reflect the way old memories are retrieved and retold in the real world throughout the life span. Our data suggest that the level of event-specific memory information (internal details) remained stable and even increased over time, with virtually no forgetting. Most striking, the memories were embellished by the addition of external details, connecting them to other memories within the larger context of the participants' lives. While the exact mechanisms of this expansion process are unknown, it appears that Bartlett was at least partly correct in emphasizing the constructive and reconstructive nature of human episodic memory. We are, indeed, storytellers.

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APPENDIX

The following is an example of a single detail that is mentioned during all six retrieval sessions taken from a description of a memory for the participant's first plane flight. Note the increase in word count and detail between Day 1 and 7, and the general maintenance of the nearly verbatim account of that detail throughout the subsequent retrieval sessions. Most importantly, note the addition of new details at the follow-up retrieval session that occurred over a year later.

Day 1

"I flew on Frontier Airlines to Flagstaff."

Day 7

"I bought some stock in Frontier Airlines. The original Frontier Airlines. This was the days before the hub and spoke system became the norm, so they still had point to point flights. So they offered direct service between Tucson and Flagstaff."

Day 14

"I had got a bunch of stock on Frontier Airlines, the original Frontier not the airline that now operates under that name. And I took a trip that summer to Flagstaff this being before the days of the hub and spoke system came into use in the Airlines, and there was actually a direct flight from Tucson to Flagstaff, they stopped in Phoenix."

Day 21

"I had purchased some stock in Frontier Airlines. The original Frontier Airlines, not the airline that now operates under that name. This was before the hub and spoke system came into use, there was a direct flight between Tucson and Flagstaff which I believe Phoenix was en route."

Day 28

"I had purchased stock from Frontier Airlines, the original Frontier Airlines and this being in the days before the hub and spoke system the Airlines still use. There was actually a direct flight from Tucson to Flagstaff with a stop to Phoenix."

1 Year Follow-up

"At that time many Airlines had programs for younger travelers with discounted fares and other goodies and upgrades. Frontier was one of the major carriers out of Tucson at that time

not to be confused with the current version of Frontier Airlines which is a completely different company. At that time this was before the hub and spoke system so you could really fly from point to point. And there was a flight out of Tucson that went through Flagstaff.”

Figure 1.

Mean word count (1a), mean total (internal plus external) memory details (1b), mean editorial details (1c), and mean phrase consistency measures (1d) for the Multiple Retrieval condition taken from Nadel et al., (2007), *Neural Plasticity*, 2007, 1–14. Note that these results were taken from all 12 participants, eight of whom participated in the current study. (* $p < .05$, ** $p < .01$, *** $p < .005$)

Figure 2.

Mean word count (2a), mean internal detail count (2b), mean external detail count (2c), and mean editorial detail count (2d) for Remote, Recent, and Multiple Retrieval conditions from the original study (Nadel et al., 2007) compared to the follow-up retrieval session. Note that scales vary by detail type. (Initial = Day 1 for Remote and Multiple Retrieval and Day 28 for Recent Retrieval, Intermediate = Day 28 for Multiple Retrieval, and Follow-up = 1–2 years after the original study for all retrieval conditions)

Table 1

Mean rating scores for each retrieval condition

		Importance then	Importance now	Emotionality then	Emotionality now	Vividness of recollection	Positive/ Negative	Arousal level
MULTIPLE	Initial	4.16	2.27	3.87	2.01	3.69	0.86	3.95
	follow-up	4.05	2.30	3.87	1.90	3.53	0.73	3.79
REMOTE	Initial	4.32	2.50	4.02	2.13	3.60	0.79	3.87
	follow-up	4.14	2.31	3.97	2.12	3.33	0.85	3.76
RECENT	Initial	4.36	2.68	4.19	2.39	3.70	0.85	4.00
	follow-up	4.25	2.31	4.00	2.02	3.52	0.61	3.82

Table 2

Mean consistency measure between original and follow-up studies for Multiple Retrieval condition

Number of previous repetitions	Five	Four	Three	Two	One
Probability of repetition	0.65	0.48	0.35	0.31	0.15

Table 3

Mean proportions of new details to total details for the Multiple Retrieval condition

Proportion of New Details to Total Details				
Day 7	Day 14	Day 21	Day 28	Follow-up
0.56	0.39	0.30	0.25	0.40