

# A novel study: Forgetting curves and the reminiscence bump

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This study examined the forgetting curves for information read in a novel. People read a 10-chapter novel where each chapter covered an approximately 10-year period in the life of the protagonist. After reading the entire novel, participants completed various memory tests in which they summarised the novel, provided associated information from cues, and answered specific questions. Performance was plotted as the amount of information or the accuracy of question answering for each chapter. All of the memory tests revealed similar patterns: (a) better performance for early information (a primacy effect), (b) a bump in performance when the protagonist was approximately 20 years old, and (c) a smaller bump in performance when the protagonist began a career later in life. These results are considered in the context of theories of forgetting, autobiographical memory, and situation models.

**Keywords:** Forgetting curve; Reminiscence bump; Narrative; Autobiographical memory.

The aim of this project was to assess memory for information learned while reading a novel. In particular, we were interested in the forgetting curves of this information. That is, to what extent does memory for information learned from such a complex source conform to the principles of memory retrieval? In the experiment, people read *The Stone Diaries* (Shields, 1994), a novel that describes the entire lifetime of the main character, Daisy Goodwill Flett, from her birth to her death at old age. Does memory for this sort of information show a classic forgetting curve across the novel such as a recency effect, a primacy effect

for material presented near the beginning of the novel, or some other pattern? We first present a brief overview of different patterns of data that have been observed with regard to forgetting curves and long-term memory performance. After this we present data from our novel study.

## MEMORY AND SERIAL POSITION

Over the years research on long-term memory has established a number of important principles. For example, with recency effects people typically

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remember more recent information better than older information. An example of this is Ebbinghaus's (1885/1964) classic forgetting curve in which the more time that has elapsed the more likely that information will be forgotten. While theories of memory may vary in the precise form of this forgetting curve (e.g., a logarithmic or power function), most theories share the view that there is a decline in availability with the passage of time as the memory traces become more and more difficult to retrieve. A simple prediction of memory for information learned while reading a novel is that as time passes throughout the course of reading the novel, information will continue to be forgotten, with memory for items learned near the end of the book being remembered better than information read earlier.

In contrast to this, there may also be a primacy effect in which earlier-encountered information is better remembered. This may occur for a number of reasons. It may be because this information is better rehearsed due to a lack of proactive interference (e.g., Atkinson & Shiffrin, 1968) or because subsequent events are more likely to cause a person to remember prior events, thereby strengthening them because this earlier-encountered information is more novel (Rubin, Rahal, & Poon, 1998), or some other reason. A simple prediction of this principle is that memory should be better for information read at the beginning of the novel. Of course, it is possible for both primacy and recency effects to be observed, as in the classic serial position curve (Healy, Havas, & Parker, 2000).

A third possibility comes from research on autobiographical memory. In this field there is an interesting deviation to the standard forgetting curve. Specifically, there is a period of better than expected memory for autobiographical events that occurred around the age of 20. This effect has been referred to as the reminiscence bump. A number of explanations have been provided for this, including the ideas that there are a larger number of novel experiences at this time in people's lives (Jansari & Parkin, 1996; Robinson, 1992), people are at their peak neurologically (Rubin et al., 1998), this is when people establish their identity (e.g., Conway, 2005; Conway, Singer, & Tagini, 2004), autobiographical memories are a part of a self-narrative (Fitzgerald, 1988, 1996), there are social schemas or life scripts about when people ought and ought not to remember portions of their lives (Berntsen & Rubin, 2002; Rubin &

Berntsen, 2003), or this is a time of major transition for people (Conway & Haque, 1999). While most reminiscence bumps occur around the age of 20, there have also been reminiscence bumps that have been observed later in life (e.g., Gülgöz & Demiray, 2006) that are attributed to unique events related to one's own family and work. When reading a novel of a person's life, while many of these factors are unlikely to be operating for the reader it is possible that some of these (e.g., social schemas) may influence later memory performance for the life of the story's protagonist. If this were the case, then one would expect that memory for events in the novel would be better when the story protagonist was around 20 years old, or during any other major change in her life.

## NARRATIVE MEMORY

Studies in text comprehension examine various aspects of what readers remember from a text that they read. While most of the research in cognitive psychology has focused on relatively small snippets of language, such as words, word pairs, or sentences, there have been a number of studies that have examined longer passages. Perhaps one of the most important findings to come out of this line of work is that different aspects of a text show different forgetting curves. It is generally agreed that people mentally represent text information at three levels: the surface form, the textbase, and the situation model (van Dijk & Kintsch, 1983). The surface form is the verbatim memory of the exact words and syntax used in the text. The textbase is a memory for the abstract propositions that were contained in the text itself. Finally, the situation model is a referential representation of the events described by the text (Johnson-Laird, 1983; Zwaan & Radvansky, 1998).

In a study by Kintsch, Welsch, Schmalhofer, and Zimny (1990), people read texts and were later tested on their memories for those texts at all three levels of representation, either immediately after reading, or after delays of up to 4 days. They observed that memory at the surface form level was very fragile. This information showed a steep forgetting curve and is consistent with other research showing that people forget verbatim information quite rapidly, often within a few seconds or minutes (Sachs, 1967). In comparison, memory at the textbase level also showed a

forgetting curve, although it was not as steep as with the surface form. Still, there was a loss of information over time. Finally, at the situation model level, there was no evidence of forgetting across the retention period in the context of that study.

Much of the research on narrative memory uses very short stories (some as short as 2 sentences, but typically fewer than 20 sentences). Apart from our own study, we know of only one other (Stanhope, Cohen, & Conway, 1993) that has systematically investigated memory for narrative information in a novel. This was a study of how well people retained memories from Charles Dickens's novel *Hard Times*. Stanhope et al. examined how well memories of the story and character names were retained over time, as long as 39 months later. While their study did test memory retention of information from a novel, it did not consider the pattern of memory performance across different time points in the novel nor did it relate performance to autobiographical memory. The goal of the current study was to examine these latter two ideas.

There are two reasons why the memories from a novel are being considered as possibly relating to autobiographical memories. First, research in narrative comprehension has shown that people can immerse themselves in a story and will typically adopt the perspective of the protagonist in a story (e.g., Zwaan, 1999). For example, people encode and remember different pieces of information about a house when reading the same story from the perspective of either a thief or a potential homebuyer (Anderson & Pichert, 1978). Also, studies have shown that readers mentally track a protagonist as he or she moves through a spatial environment (e.g., Morrow, Bower, & Greenspan, 1989). Because the novel we chose is based on the story of a person's life, it is essentially a fictional biography. Thus, if readers are taking the perspective of the protagonist it is possible that the readers would construct vicarious autobiographical memories of the protagonist's life story.

The second reason why memories from a novel are being related to autobiographical memory patterns is that other data from this novel study have shown similarities to autobiographical memories (Radvansky, Copeland & Zwaan, 2005). That analysis looked at the retrieval of information from individual episodes from the novel, and compared memory for this information with autobiographical memory for episodes. The ana-

lysis revealed that there was a high degree of correspondence between narrative and autobiographical memory. In particular, consistent with previous autobiographical memory studies (e.g., Anderson & Conway, 1993), in both cases people found it easier to retrieve episodes in a forward temporal order relative to a backward or relative importance order. Furthermore, consistent with previous research on narrative comprehension, degree of causal connectivity was found to be an important predictor of future performance, with more connected items being remembered better. However, this analysis did not provide any information about the forgetting curves of the learned information.

The goal of this study was to examine forgetting curves for information learned about various time points of a protagonist's life in an autobiographical novel. The next section outlines possible outcomes that may be observed. These include effects of recency, primacy, and a reminiscence bump.

## THE PRESENT EXPERIMENT

In the experiment people read a novel, *The Stone Diaries* (Shields, 1994), that describes a woman's life in chronological order from birth to death at old age.<sup>1</sup> Each chapter of the novel represents a distinct time period in the protagonist's life. After completing the novel participants were given a wide range of memory tests, such as summarising the novel, linking ideas to presented cues, and answering specific comprehension questions. The data from a number of these tests were analysed with respect to their serial position in the novel to determine the relative forgetting curves. While many tests were conducted, not all of them could be used in these analyses. The major impediment for some of them was that they did not always test a representative sample of the various chapters

<sup>1</sup> One possible influence on the results in the current study was that the novel was about a woman's life. While it is possible that male readers may not have identified as strongly with the protagonist because of this, we do not think that this is likely. First, the novel described events that were relatable to people of either gender (e.g., illness, marriage, career, etc.). Second, all of our participants were volunteers (i.e., they were not participating in exchange for class credit or pay) who were motivated to read this particular novel. While the analysis of gender identification between the reader and the protagonist may be of interest to future studies, this idea is beyond the scope of the current study.

(i.e., time periods) in the novel. Only those tests that considered the majority of the chapters were included.

As outlined in the introduction, there are three possibilities for the patterns of memory performance. First, memory could show a recency effect. Second, memory recall could show a primacy effect. Finally, because this novel is the story of a woman's life, memory performance could reflect principles of autobiographical memory, namely a reminiscence bump with unexpectedly good performance for events from around the age of 20 or any other major transitions in a person's life.

An important point to note is that these memory tasks were not originally intended to be used to evaluate forgetting curves when the data were collected. However, given the universality of these principles, some clear, consistent effects should be observed. More importantly, this provides a stronger test of these forgetting curve principles.

## METHOD

### Participants

A total of 38 people participated in this experiment; 24 undergraduate and graduate students from the University of Notre Dame and 14 undergraduates from Florida State University. They were recruited from psychology classes and from fliers and postings that were advertised around campus. In exchange for their participation, all participants received a paperback copy of the novel upon completion of all tasks. It should be noted that, because the participants did not receive course credit nor did they receive pay, the participants were all motivated to read this novel and were allowed to drop out at any point (none of the participants dropped out).

### Materials and procedure

*The novel.* The novel *The Stone Diaries* by Carol Shields (1994) was used in this study. This book consists of 10 chapters, 361 pages, 5896 sentences, and 96,389 words (see Appendix). Each chapter advanced approximately 10 years from the previous one, and all of the chapter titles included the year. Chapters 1 through 10 took place in the following years, respectively: Chapter 1, 1905 (birth/0 years); Chapter 2, 1916 (11 years);

Chapter 3, 1927 (22 years); Chapter 4, 1936 (31 years); Chapter 5, 1947 (42 years); Chapter 6, 1955 (50 years); Chapter 7, 1965 (60 years); Chapter 8, 1977 (72 years); Chapter 9, 1985 (80 years); and Chapter 10, 199–(unspecified/85+ years). The book was scanned into computer files (ASCII) to be presented chapter-by-chapter one sentence at a time. Breaks such as a new paragraph or a new section within a chapter were omitted.

*Reading.* Participants read the book on a computer in a laboratory on the Notre Dame or Florida State campuses. Reading was self-paced and the computer presented one sentence at a time; participants advanced to the next sentence by pressing the right mouse button. Participants were required to read an entire chapter in a session and were allowed to read two in a session if they wished. Participants were also allowed to complete up to two sessions per day if they were separated by at least an hour (i.e., maximum of four chapters per day); participants typically read one chapter per session ( $M = 1.3$ ) and had one session per day. A final constraint was that no more than 10 days could pass between sessions; on average there were about 3 days between sessions ( $M = 2.9$ ).

*Memory tests.* After reading all of the chapters, there was an approximately 8- to 9-day delay (minimum was 7 days) before memory tests were conducted ( $M = 8.5$ ). Testing took place so that the tasks were distributed across either two or three sessions. People completed the tasks in the following order (tasks analysed in this study are in italics): (a) *Summary*, (b) *Character Listing*, (c) *Cued Recall Task*, (d) *Episodic Recall*, (e) *Episodic Recognition*, and (f) *Specific Questions*. The tasks that were used in the analyses for this study are described first, followed by a brief description of the other tests. Some analyses of memory tests unrelated to the current focus that used this data set are reported in a study by Radvansky et al. (2005).

The first task was a written summary of the novel. The only instructions were that participants should approach the summary as if they were having a short conversation about the novel with a friend. These summaries were scored by first breaking each one down into individual idea units (i.e., propositions). After this, each proposition was grouped by the chapter from which the information came.

The second task analysed was a cued recall task. It consisted of a number of memory probes that were words (e.g., Malvern pudding), phrases (e.g., Behind the Lake Lemon home), names (e.g., Barker Flett), or dates (e.g., 1955) from the book. People were asked to recall events in the novel that they were reminded of for each probe. In total 177 probes were presented to each reader. For the purposes of this analysis, responses to 11 of the probes were of primary interest. The first was the name of the protagonist (i.e., Daisy Goodwell Flett). The remaining 10 were the year in which each chapter took place. This was used so that responses could easily be scored and classified according to each chapter and decade of the protagonist's life. Responses were scored by breaking down each recall into individual propositions. For the protagonist cue, each proposition was coded based on the chapter or chapters in which the information was mentioned. These were then summed for each chapter. For the year cues, scores consisted of the number of accurate propositions recalled for each cue.

The third task that was analysed was the Episodic Recall of details. In this task, people were presented with 12 major events (e.g., Daisy and Harold's Honeymoon) from the novel. For each event, the task was to list up to 10 details or sub-events that pertained to the major event. Participants were asked to list these details in either a forward order (i.e., chronological), backward order, or in order of importance. Recollections based on these three types of instructions were analysed and reported by Radvansky et al. (2005), but were not of interest in the current study. Instead, the current analysis focused only on the number of recollections made by participants for each event. Because this task was not originally intended for the analyses in the current study, not all chapters were represented by a major event; also, some chapters were represented by more than one major event. For those chapters where more than event could apply, the mean number of detail recollections for all applicable events was used as a score.

The final task of interest was a specific question test in which people were asked short-answer questions about the novel. Some questions could be answered with one word and some required at least a phrase or a sentence to clearly express the idea. In total, there were 73 questions, with a mean of 7.2 (range: 3–10) questions related to each chapter (1 question could not be categorised into a single chapter). Unfortunately there was an

unequal number of questions per chapter: Chapter 1 (8), Chapter 2 (8), Chapter 3 (8), Chapter 4 (8), Chapter 5 (5), Chapter 6 (8), Chapter 7 (8), Chapter 8 (10), Chapter 9 (6), and Chapter 10 (3). Because of this, three questions were randomly chosen from each chapter prior to scoring for the analyses. Responses were scored using a lenient criterion. That is, proper names were not required as long as the description in the answer was unambiguous (e.g., either "Cuyler" or "Daisy's father" were acceptable responses for the question "Who built Goodwill Tower?").

Thus four basic memory tests were used: (1) summarising the novel, (2) responding to cued words, (3) listing events for a theme, and (4) answering specific questions. The four memory tests are similar to those that have been used in autobiographical memory research (Rubin, 2005). The first test, summarising the novel, most closely corresponds to autobiographical memory studies such as those used by Fromholt et al. (2003) in which people were asked to freely describe a narrative of their life history during a 15-minute interview. The second test, responding to cued words, is somewhat similar to the Galton-Crovitz cueing technique that is also used in autobiographical studies (e.g., Crovitz & Schiffman, 1974). The listing events task is based on the procedure used by Anderson and Conway (1993) to examine the organisation of autobiographical memories. Finally, the specific questions task is similar to approaches used to examine memories for specific autobiographical events (e.g., Talarico & Rubin, 2003).

In addition to the tasks described above, people completed a number of other tasks. One task asked participants to list as many characters as they could from the novel. This was not used in the analyses because the majority of the characters were involved in several chapters and there were extremely few characters specific to a particular chapter. In another task, people completed a recognition test based on their responses to the episodic recalls. These data were not included in the analyses because the stimuli differed for each participant, making it difficult to compare performance across participants.

## RESULTS

The following sections examine the forgetting curves for the following tasks: Novel Summaries, Cued Protagonist, Cued Years, Specific

Questions, and a Combined Analysis. To make it easier to compare the results of the different tasks, and to allow the data to be more easily combined, all results were transformed to *z*-scores based on the mean and standard deviation for each task. In addition, it is possible that in the more open-ended tasks (i.e., Novel Summaries, Cued Protagonist, and Cued Years), people may recall more from some chapters because those chapters were longer than others. To correct for this, these analyses divided the number of recalls for each chapter by the length of each chapter (i.e., number of words). The number of words for each chapter is listed in the Appendix.

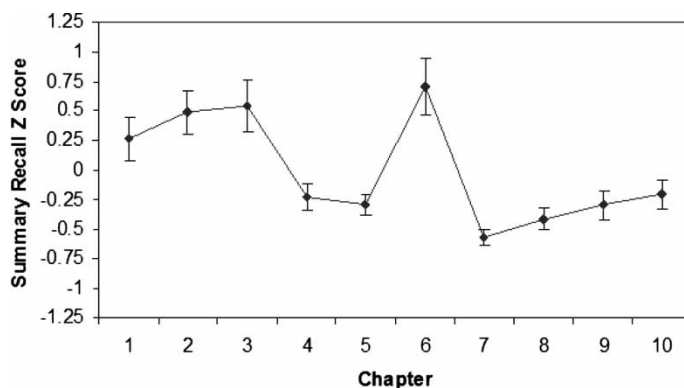
Overall, the results suggested a primacy effect as well as two reminiscence bumps, one around the age of 20, and the other in the protagonist's 50s when she underwent a major life transition from being a housewife to the working world. The sample size differs for the various measures because participants from Florida State University were not asked to complete the Cued Years and Cued Protagonist tasks. Also, the summaries for two participants were excluded because they wrote about their opinion of the novel (i.e., a review) instead of summarising (as instructed).

## Novel Summaries

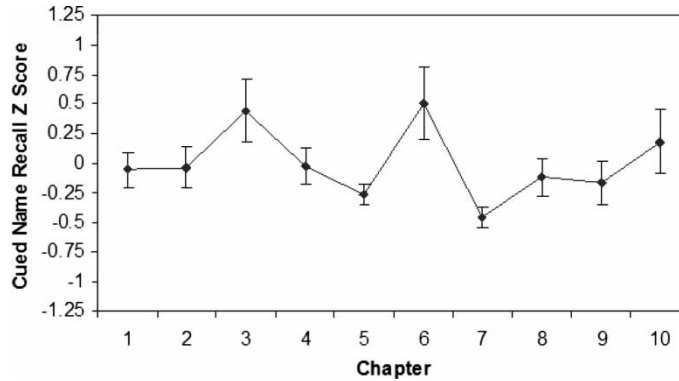
The reported results are *z*-scores based on the percentage of propositions accurately recalled for each chapter and these are shown in Figure 1. Analysis of the forgetting curve revealed significant linear,  $F(1, 358) = 24.34$ ,  $MSE = 0.94$ ,  $p < .001$ , and quadratic components,  $F(2, 357) = 12.40$ ,

$MSE = 0.94$ ,  $p < .001$ . The adjusted  $R^2$  was similar for the linear ( $R^2 = .061$ ) and quadratic ( $R^2 = .060$ ) components. Visual inspection suggests that there is a primacy, but not a recency effect, as well as a reminiscence bump. To further examine primacy and recency effects, recall data for the first three chapters (i.e., Chapters 1–3) were compared to both the middle four (i.e., Chapters 4–7) and final three chapters (i.e., Chapters 8–10). A within-participants ANOVA was significant,  $F(1, 35) = 30.21$ ,  $MSE = 0.320$ ,  $p < .001$ . There was a clear primacy effect. People recalled more information from earlier in the novel ( $M = 0.43$ ,  $SE = 0.17$ ) than the middle ( $M = -0.10$ ,  $SE = 0.12$ ),  $F(1, 35) = 23.27$ ,  $MSE = 0.214$ ,  $p < .001$ , and more from the middle than the last section ( $M = -0.30$ ,  $SE = 0.09$ ),  $F(1, 35) = 7.31$ ,  $MSE = 0.106$ ,  $p < .05$ .

Inspection of Figure 1 suggests a couple of locations for a reminiscence bump at Chapters 3 (age 22) and 6 (age 50). To test for the first bump, recall for Chapter 3 was compared to performance for Chapters 2 and 4. The recall *z*-score for Chapter 3 ( $M = 0.54$ ,  $SE = 0.21$ ) was not significantly different from Chapter 2 ( $M = 0.49$ ,  $SE = 0.18$ ),  $F < 1$ , but was for Chapter 4 ( $M = -0.23$ ,  $SE = 0.11$ ),  $F(1, 35) = 39.47$ ,  $MSE = 0.269$ ,  $p < .001$ . For the second bump, the recall *z*-score for Chapter 6 was compared to Chapters 5 and 7. The Chapter 6 bump ( $M = 0.70$ ,  $SE = 0.24$ ) was revealed with better performance for Chapter 6 than for both Chapters 5 ( $M = -0.29$ ,  $SE = 0.09$ ),  $F(1, 35) = 28.92$ ,  $MSE = 0.608$ ,  $p < .001$  and 7 ( $M = -0.57$ ,  $SE = 0.06$ ),  $F(1, 35) = 38.85$ ,  $MSE = 0.749$ ,  $p < .001$ . Overall, this pattern of data is generally consistent with the idea that reminiscence bumps occurred in people's memories of the information they learned in the novel.



**Figure 1.** Percentage of propositions recalled in novel summary by chapter (y-error bars denote standard error).



**Figure 2.** Percentage of propositions recalled during cued recall task using protagonist's name by chapter (y-error bars denote standard error).

### Cued Protagonist

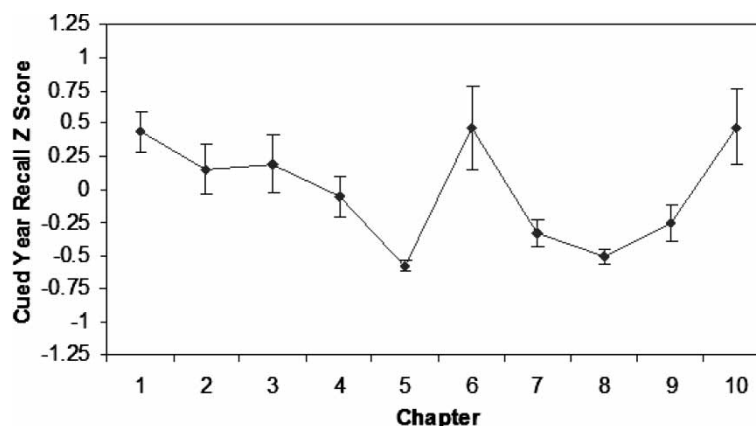
The z-scores based on the percentage of propositions recalled for each chapter based on the Protagonist cues are shown in Figure 2. When people were cued with the protagonist's name there was no clear evidence of a primacy nor a recency effect. The trend analysis revealed that both linear and quadratic components were not significant, both  $F_s < 1$ . The adjusted  $R^2$  was similar for the linear ( $R^2 = -.003$ ) and quadratic components ( $R^2 = -.007$ ).

For the reminiscence bump, there were more propositions recalled for Chapter 3 ( $M = 0.44$ ,  $SE = 0.27$ ) than both Chapter 2 ( $M = -0.04$ ,  $SE = 0.17$ ),  $F(1, 24) = 7.61$ ,  $MSE = 0.372$ ,  $p < .05$ , and Chapter 4 ( $M = -0.02$ ,  $SE = 0.15$ ),  $F(1, 24) = 5.09$ ,  $MSE = 0.530$ ,  $p < .05$ . For the later bump, the percentage for Chapter 6 ( $M = 0.50$ ,  $SE = 0.30$ ) was larger than Chapter 5 ( $M = -0.27$ ,  $SE = 0.09$ ),  $F(1, 24) = 8.69$ ,  $MSE = 0.858$ ,  $p < .01$ , and Chapter 7 ( $M = -0.46$ ,  $SE = 0.09$ ),

$F(1, 24) = 15.82$ ,  $MSE = 0.729$ ,  $p < .01$ . Thus, for the Cued Protagonist task, there was clear evidence for the two reminiscence bumps.

### Cued Years

The z-scores based on the percentage of propositions that were recalled for each chapter based on the Year cues are shown in Figure 3. A trend analysis revealed that the linear component was not significant,  $F(1, 248) = 2.58$ ,  $MSE = 0.994$ ,  $p = .11$ , but the quadratic component was significant,  $F(2, 247) = 6.43$ ,  $MSE = 0.958$ ,  $p < .01$ . The adjusted  $R^2$  was larger for the quadratic ( $R^2 = .042$ ) than the linear component ( $R^2 = .006$ ). Visual inspection of the graph suggests the presence of a primacy effect, a reminiscence bump, and possibly a recency effect. A repeated-measures ANOVA revealed a difference among the primacy, middle, and recency sections,  $F(1, 24) = 4.46$ ,  $MSE = .357$ ,  $p < .05$ . While recall for



**Figure 3.** Percentage of propositions recalled during cued recall task using years by chapter (y-error bars denote standard error).

the first section ( $M = 0.26, SE = 0.16$ ) was better than for both the middle ( $M = -0.12, SE = 0.11$ ) and final sections ( $M = -0.10, SE = 0.09$ ),  $F(1, 24) = 9.61, MSE = 0.193, p < .01$ , and  $F(1, 24) = 4.46, MSE = 0.357, p < .05$ , respectively, recall for the final section was not better than the middle section,  $F < 1$ .

As for the reminiscence bump analysis, recall for Chapter 3 was compared to Chapters 2 and 4. Recall for Chapter 3 ( $M = 0.20, SE = 0.22$ ) did not differ from Chapter 2 ( $M = 0.15, SE = 0.19$ ),  $F < 1$ , but was marginally significantly greater than for Chapter 4 ( $M = -0.05, SE = 0.15$ ),  $F(1, 24) = 3.05, MSE = 0.252, p = .09$ . Thus, there is some mild consistency with the idea that a reminiscence bump may be occurring at this point in the protagonist's life. Furthermore, there was a larger percentage of propositions recalled for Chapter 6 ( $M = 0.47, SE = 0.32$ ) than for Chapters 5 ( $M = -0.58, SE = 0.04$ ),  $F(1, 24) = 10.71, MSE = 1.268, p < .01$ , and 7 ( $M = -0.33, SE = 0.10$ ),  $F(1, 24) = 5.76, MSE = 1.387, p < .05$ . While the statistical results are not as clear, the pattern for this bump is similar to that observed in the analyses for the Novel Summaries.

### Episodic Recall

The z-scores based on the percentage of details recalled per event for each applicable chapter are listed in Figure 4. For this analysis, neither the linear,  $F < 1$ , nor the quadratic,  $F < 1$ , components were significant. The adjusted  $R^2$  was similar for the linear ( $R^2 = -.002$ ) and quadratic ( $R^2 = -.002$ ) components. Thus, there do not appear to be primacy or recency effects for episodic recall.

Tests of possible reminiscence bumps were done by comparing the percentage of details recalled for Chapters 2 and 3 (no events corresponded with Chapter 4), and for Chapters 5, 6, and 7. Recall was higher for Chapter 3 ( $M = 0.47, SE = 0.11$ ) than Chapter 2 ( $M = -0.20, SE = 0.18$ ),  $F(1, 24) = 19.17, MSE = 0.293, p < .001$ . This supports the presence of a reminiscence bump. Recall was higher for Chapter 6 ( $M = 0.22, SE = 0.14$ ) than both Chapter 5 ( $M = -0.58, SE = 0.26$ ),  $F(1, 24) = 18.30, MSE = 0.438, p < .001$ , and Chapter 7 ( $M = -0.23, SE = 0.25$ ),  $F(1, 24) = 7.25, MSE = 0.358, p < .05$ . Thus, memory recall for this task supports the existence of the two reminiscence bumps.

### Specific Questions

The z-scores based on the accuracy percentage to the specific questions for each chapter are shown in Figure 5. Both the linear,  $F(1, 378) = 5.91, MSE = 0.987, p < .05$ , and the quadratic components were significant,  $F(2, 377) = 3.17, MSE = 0.989, p < .05$ . The adjusted  $R^2$  was similar for the linear ( $R^2 = .013$ ) and quadratic components ( $R^2 = .011$ ). A repeated-measures ANOVA was conducted and revealed a difference among the primacy, middle, and recency sections,  $F(1, 37) = 10.48, MSE = .248, p < .01$ . Recall for the first section ( $M = 0.20, SE = 0.09$ ) was better than for the final section ( $M = -0.18, SE = 0.06$ ),  $F(1, 37) = 10.48, MSE = 0.248, p < .01$ , but was not significantly better than the middle ( $M = -0.01, SE = 0.08$ ),  $F(1, 37) = 1.76, MSE = 0.475, p = .19$ . Recall for the final section was not better than the middle section,  $F(1, 37) = 1.64, MSE = 0.299, p = .21$ .

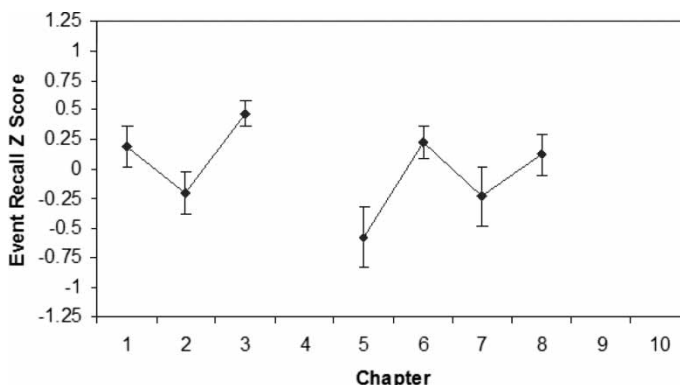
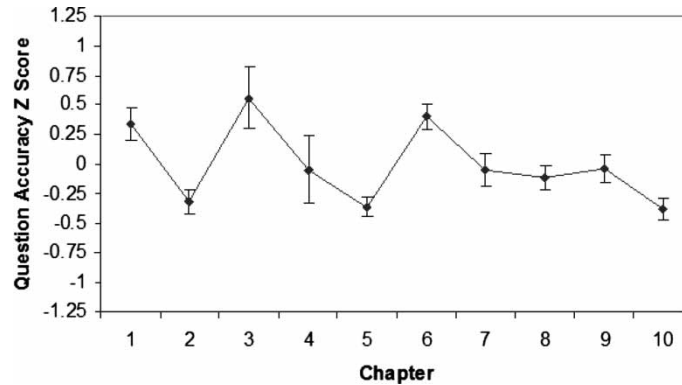


Figure 4. Percentage of details recalled per specific event by chapter (y-error bars denote standard error).



**Figure 5.** Accuracy percentage of responses for specific comprehension questions by chapter (y-error bars denote standard error).

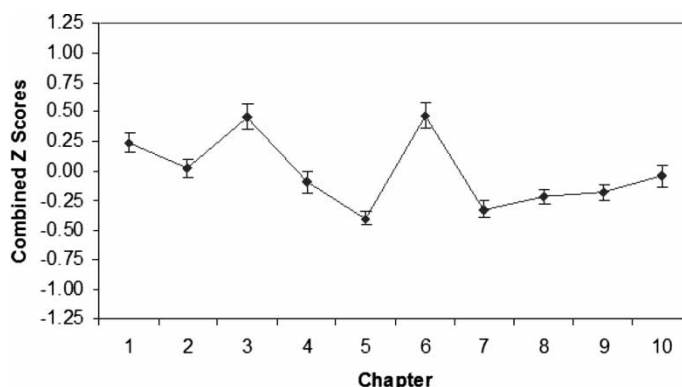
For the reminiscence bump analysis, there was a larger percentage of accurate responses for Chapter 3 ( $M = 0.56$ ,  $SE = 0.26$ ) than for Chapter 2 ( $M = -0.31$ ,  $SE = 0.10$ ),  $F(1, 37) = 8.52$ ,  $MSE = 1.695$ ,  $p < .01$ , but the difference for Chapter 4 was not significant ( $M = -0.05$ ,  $SE = 0.28$ ),  $F(1, 37) = 1.94$ ,  $MSE = 3.580$ ,  $p = .17$ . For the later bump, the percentage for Chapter 6 ( $M = 0.40$ ,  $SE = 0.11$ ) was larger than both Chapters 5 ( $M = -0.36$ ,  $SE = 0.08$ ),  $F(1, 37) = 41.69$ ,  $MSE = 0.264$ ,  $p < .001$ , and 7 ( $M = -0.05$ ,  $SE = 0.14$ ),  $F(1, 37) = 6.29$ ,  $MSE = 0.621$ ,  $p < .05$ . Thus, this analysis revealed that there are two bumps.

### Combined measures

Because there was a fairly consistent pattern of performance across the various measures, and because not all of the effects were significant, all of the z-scores from the tasks were combined to increase power. That is, each participant's z-score for each chapter from each task was included in this analysis. The combined data for the five tasks

are shown in Figure 6. A trend analysis supported the existence of a primacy effect because the linear component was significant,  $F(1, 1413) = 24.10$ ,  $MSE = 0.981$ ,  $p < .001$ . The quadratic component was also significant,  $F(2, 1412) = 13.23$ ,  $MSE = 0.980$ ,  $p < .001$ . The adjusted  $R^2$  was similar for the linear ( $R^2 = .016$ ) and the quadratic components ( $R^2 = .017$ ). A repeated-measures ANOVA was done to compare recall for the primacy, middle, and recency sections; the result was significant,  $F(1, 148) = 35.18$ ,  $MSE = .277$ ,  $p < .001$ . There was a clear primacy effect, but no recency effect. Recall for the first section ( $M = 0.24$ ,  $SE = 0.07$ ) was better than for both the middle ( $M = -0.09$ ,  $SE = 0.06$ ) and final sections ( $M = -0.12$ ,  $SE = 0.06$ ),  $F(1, 148) = 33.53$ ,  $MSE = 0.247$ ,  $p < .001$ , and  $F(1, 148) = 35.18$ ,  $MSE = 0.277$ ,  $p < .001$ , respectively. Recall for the middle section was not different than the final section,  $F < 1$ .

For the initial reminiscence bump, z-scores for Chapter 3 were compared to those for Chapters 2 and 4. Performance for Chapter 3 ( $M = 0.46$ ,  $SE = 0.11$ ) was greater than for Chapters 2



**Figure 6.** Percentage of items recalled per chapter for all measures combined (y-error bars denote standard error).

( $M = 0.02$ ,  $SE = 0.08$ ),  $F(1, 148) = 20.34$ ,  $MSE = 0.696$ ,  $p < .001$ , and 4 ( $M = -0.09$ ,  $SE = 0.10$ ),  $F(1, 123) = 14.27$ ,  $MSE = 1.323$ ,  $p < .001$ . This supports the existence of a reminiscence bump. To examine the secondary bump, performance for Chapter 6 was compared to Chapters 5 and 7. Recalls for Chapter 6 ( $M = 0.47$ ,  $SE = 0.11$ ) were greater than recall for both Chapter 5 ( $M = -0.40$ ,  $SE = 0.06$ ),  $F(1, 148) = 89.51$ ,  $MSE = 0.633$ ,  $p < .001$ , and Chapter 7 ( $M = -0.32$ ,  $SE = 0.07$ ),  $F(1, 148) = 59.68$ ,  $MSE = 0.788$ ,  $p < .001$ . Thus, the results also support the existence of a secondary reminiscence bump.

## DISCUSSION

This study examined forgetting curves for information that people read in a novel. Earlier we described possible memory patterns: (a) a recency effect, (b) a primacy effect, or (c) patterns consistent with autobiographical memory, such as a reminiscence bump. Memory performance on the five different memory tests showed forgetting curves that revealed an advantage for early but not later information (i.e., a primacy effect but no recency effect). In addition to the primacy effect, memory performance was also better for Chapters 3 and 6, relative to the surrounding chapters. The first bump, for Chapter 3 in which the protagonist of the story was 22 years old, corresponds to a typical reminiscence bump around the age of 20, and the second bump corresponds to a significant transition later in life; in this case, the start of a new career in her 50s after having previously been a housewife. Thus, memory performance in this study included a primacy effect with two reminiscence bumps.

### Primacy and recency

At first it may seem surprising that an effect of primacy was observed, but not recency. Both Ebbinghaus's forgetting curve and studies of autobiographical memory tend to show better performance for more recent information. However, effects of primacy may be attributed to a greater amount of rehearsal. That is, information about characters and events that occurred earlier in the novel was likely to have been accessed while reading to aid comprehension. Early in-

formation may have served a large role in creating a framework for organising events throughout the novel.

Along this line, the primacy effect in this study may have resulted from the formation of a first impression. When we learn information about other people our initial encounters, or first impressions, tend to play a disproportionate role in our understanding of them (Asch, 1946). Thus, people may have formed an initial impression of the protagonist by paying more attention to actions and thoughts during the first couple of chapters. However, this explanation does not seem likely in the current study. The main reason is that the primacy effect was primarily a result of a high level of memory recall for Chapter 1, not Chapter 2,  $F(1, 148) = 9.20$ ,  $MSE = 0.397$ ,  $p < .01$  for the combined analysis data. In this novel Chapter 1 dealt with the birth of the protagonist, and thus described very few of her actions and thoughts. If people were relying on a first impression of the protagonist, we would have expected to see much better performance for Chapter 2; however, this was not observed.

Another possible explanation for a primacy effect, but no recency effect, could be based on serial recall demands. In a study such as this, with a large number of memory tests, people may have put forth a lot of effort when first responding, and may have become fatigued later, leading them to recall less information. However, this is not likely in the current study. First, none of the memory tasks explicitly asked for serial recall. In four of the five memory tests (i.e., cued year, cued name, event recalls, and specific questions), probes and questions were presented in a random order. The only memory test in which serial recall was likely was for summarising the novel. Here, most participants recalled information in a serial order; however, this was not an explicit instruction given to participants.

The lack of a recency effect could be due to a number of reasons. First, the recency effect may have been diminished because in this study there was a minimum of a 1-week delay between when the participants finished the final chapter and when the memory tests were conducted. Second, as stated earlier, events that occurred earlier in the novel may have been rehearsed or accessed more than those that occurred later. The third possible reason is based on the fact that the participants in the current study were all young

adults. It may be that, because the participants are younger than the protagonist was towards the end of the novel, that it was more difficult to personally relate to those events than for those that occurred earlier in the protagonist's life. However, this latter explanation seems less likely because many of the events described in the final chapters were not necessarily exclusive to older adults (e.g., being in the hospital, travelling to Europe, etc.).

The two memory tasks that showed the closest pattern to a recency effect were the two cued recall tasks. For both of these, there was a marginally significant increase in recall performance for Chapter 10 (i.e., the final chapter), relative to Chapter 9,  $F(1, 24) = 3.94$ ,  $MSE = 0.386$ ,  $p = .06$ , and  $F(1, 24) = 3.79$ ,  $MSE = 1.730$ ,  $p = .06$ , for the Cued Protagonist and Cued Year tasks, respectively. This is not surprising because cued recall tasks (e.g., Galton-Crovitz) that have been used to study autobiographical memory typically show recency effects (although see Janssen, Chessa, & Murre, 2005, for analyses that remove effects of forgetting).

A final point about the lack of a recency effect is that even though cued recall tasks can elicit recency patterns, not all studies of autobiographical memories have shown one. For example, recency effects were less likely to be observed when asking people to recall important memories (Rubin & Schulkind, 1997). Also, they are diminished if people are asked to recall memories as a life-narrative (Fromholt et al., 2003). In the current study some of our memory tasks had instructions that were similar to requesting a life-narrative. For example, in our first task people were asked to summarise the novel; although our instructions did not explicitly ask for recollection as a life-narrative, it is likely that people would interpret our instructions to have a similar meaning.

## Reminiscence bump

The forgetting curves that were observed in this study are consistent with research that has investigated reminiscence bumps in autobiographical memory, typically around the age of 20 (e.g., Rubin, Wetzler, & Nebes, 1986). In addition, the later bump is similar to those observed by Conway and Haque (1999) in which important

transitional life events led to more information reported from memory for that age.

The most interesting aspect of the current study is that the reminiscence bump has been traditionally observed for autobiographical memories; not for memories of another person's life or from a narrative. Explanations for the presence of a reminiscence bump have stated that the bump is a result of forming one's identity (Conway, 2005), a peak in physiological functioning (Rubin et al., 1998), major life transitions (Conway & Haque, 1999), or a result of using life scripts (Rubin & Berntsen, 2003). Of these possibilities, the results are not consistent with the first two explanations. Because people read a novel about someone else's life, they were likely not contributing to their own identity formation; thus, the first explanation is not consistent with our results. For the second explanation, all of the participants in the current study were around the age of 20 and hence should be in peak physiological functioning while encoding the events from the entire novel. Thus, based on this explanation, they should have remembered everything at an equally high level. However, they clearly showed evidence of a reminiscence bump around the age of 20.

Autobiographical recollections have been compared to life scripts, or narratives. That is, people organise their autobiographical memories around cultural norms. This explanation is consistent with this study. People seemed to recall details about important events in the protagonist's life, particularly culturally important events from Chapter 3—the protagonist's graduation from high school and first marriage. In addition, the later chapters of the novel, which contained themes of depression, hospitalisation, and death, tended to not be recalled to a great extent. This is consistent with findings by Berntsen and Rubin (2002) and Rubin and Berntsen (2003), where no reminiscence bump was observed for people's recollection of negative life events.

Another point concerning the observed reminiscence bump is that in the current study, the length of each chapter (i.e., time period) was accounted for in the analyses. This is important because previous studies have shown that authors prefer to write about topics and events that are related to the traditional reminiscence bump (e.g., Mackavey, Malley, & Stewart, 1991). However, as can be seen in the Appendix, even though

Chapters 1 and 3 contained more than 10,000 words, five other chapters were also this long; but these other chapters did not show consistently high levels of recall performance. As can be seen in Figure 6, memory recall for Chapters 2, 5, 7, and 8 was not as high despite their being similar in length to Chapters 1 and 3.

While we did account for the length of the chapters, there is another potential influence on the recall patterns. In addition to events being mentioned in the chapter in which they occurred, it is possible they may have been referred to in later chapters as well. That is, it is possible that some memories for events may have been strengthened by repeated mentions throughout the novel. While this did occur from time to time, it is also possible in studies of autobiographical memory, and does not, by itself, explain the reminiscence bump (e.g., Janssen, Chessa, & Murre, 2007).

As mentioned earlier, the presence of the second reminiscence bump is consistent with autobiographical memory research. Specifically, Conway and Haque (1999) showed that a later reminiscence bump appeared that corresponded to an important life event; in their study, it corresponded to a struggle for independence. Gülgöz and Demiray (2006) also reported a later, second reminiscence bump. In their study the second bump corresponded to important and vivid life events, particularly involving families. They suggest that it is possibly a result of vicariously experiencing events of their children. The observation of a second bump (as well as the first) in the current study is consistent with this idea. That is, it appears that in the current study that readers may have vicariously experienced the events involving the protagonist from the novel, and then their memory patterns resulted in the presence of the reminiscence bumps.

The idea that people vicariously experience the events involving the protagonist is also consistent with the situation model theory of text comprehension (e.g., Zwaan & Radvansky, 1998). An important component of situation models is that people can engage in the perspective of a protagonist (Zwaan, 1999). For example, readers appear to empathise with story characters (Allbritton & Gerrig, 1991), readers can attend to and better remember aspects of a story based on the perspective they are asked to take (Anderson & Pichert, 1978), and people show similar situation model updating effects whether they are reading

narratives about other people (Radvansky & Copeland, 2001) or experiencing events themselves (Radvansky & Copeland, 2006). This is one of the reasons why reading novels is enjoyable, because people can use their imagination to represent and experience the described events. The major difference between earlier studies and the current one is that the former mainly examined short narratives, while the latter examined a longer narrative (i.e., a novel). The findings from the current study, along with those reported by Radvansky et al. (2005), can be a starting point for expanding research of situation models to longer narratives.

Finally, it is important to understand some of the possible limitations of the current study. First, the current study only examined memory for a single novel, which limits its generalisation to a degree. In the current study people may have better remembered the information from certain chapters because they may have described more interesting events. Future studies could examine other novels to see if similar memory patterns are observed. Finally, another possible influence is that this novel was written about a woman's life. It is possible that some of the male participants in the current study had difficulty relating to the events in the novel, which may have influenced what aspects of the novel were better remembered.

## Conclusion

The goal of the current study was to examine the pattern of memory recall of individuals who read an autobiographical novel. The results showed a clear effect of primacy along with two reminiscence bumps: one observed around the age of 20, which is typical in studies of the reminiscence bump, and one bump later in life, at the time of an important life transition. These results suggest that information read in a narrative can be organised in a manner similar to memories from one's own life. These findings are consistent with a previous study by Radvansky et al. (2005) that showed similarities between narrative and autobiographical memories.

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## APPENDIX

### Corresponding dates, protagonist's age, and length (in words) of each chapter

| Chapter    | Date                  | Age       | Length<br>(in words) |
|------------|-----------------------|-----------|----------------------|
| Chapter 1  | 1905                  | 0 (birth) | 11,753               |
| Chapter 2  | 1916                  | 11 years  | 10,725               |
| Chapter 3  | 1927                  | 22 years  | 11,678               |
| Chapter 4  | 1936                  | 31 years  | 9,906                |
| Chapter 5  | 1947                  | 42 years  | 11,258               |
| Chapter 6  | 1955                  | 50 years  | 7,023                |
| Chapter 7  | 1965                  | 60 years  | 10,247               |
| Chapter 8  | 1977                  | 72 years  | 11,670               |
| Chapter 9  | 1985                  | 80 years  | 8,871                |
| Chapter 10 | 199–<br>(unspecified) | 85+ years | 3,258                |