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Remembering to Forget: The Amnesic Effect of Daydreaming

Peter F. Delaney[1], Lili Sahakyan[1], Colleen M. Kelley[2], and Carissa A. Zimmerman[2]
[1]University of North Carolina at Greensboro and [2]Florida State University

Abstract

Daydreaming mentally transports people to another place or time. Many daydreams are similar in content to the thoughts that people generate when they intentionally try to forget. Thus, thoughts like those generated during daydreaming can cause forgetting of previously encoded events. We conducted two experiments to test the hypothesis that daydreams that are more different from the current moment (e.g., in distance, time, or circumstance) will result in more forgetting than daydreams that are less different from the current moment, because they result in a greater contextual shift. Daydreaming was simulated in the laboratory via instructions to engage in a diversionary thought. Participants learned a list of words, were asked to think about autobiographical memories, and then learned a second list of words. They tended to forget more words from the first list when they thought about their parents' home than when they thought about their current home (Experiment 1). They also tended to forget more when they thought about an international vacation than when they thought about a domestic vacation (Experiment 2). These results support a context-change account of the amnesic effects of daydreaming.

Keywords

daydreams, directed forgetting, mental context, autobiographical memories, contextual change

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Imagine that the duty of representing the psychology department on the library's document-preservation committee fell to you. As the library archivists on the committee discuss the finer points of preserving one glue versus another glue, your mind—enthralling as the topic is —starts to drift. Perhaps you find yourself traveling mentally back in time to a pleasant occasion, such as your recent wedding or your honeymoon in Jamaica. While on your mental voyage, your attention is distracted from the conversation, which causes you to remember little of it later on. In fact, you may not remember much of the conversation that took place even prior to your daydreaming, as research suggests that by thinking of something else, you may forget information acquired before your attention lapsed (Sahakyan & Kelley, 2002). Thus, it is possible that at least some daydreams have an *amnesic* effect, which is the subject of this article.

A daydream is a kind of mind wandering that involves off-task thought (Smallwood & Schooler, 2006). Recent studies suggest an association between mind wandering and memory, but have focused mainly on how mind wandering can disrupt memory encoding. Mind wandering and daydreaming may impair recollection in a manner similar to the way in which dividing attention during learning does (Riby, Smallwood, & Gunn, 2008; Smallwood, Baracaia, Lowe, & Obonsawin, 2003; Smallwood & Schooler, 2006). Mind wandering also impairs understanding and memory for text (Smallwood, McSpadden, & Schooler, 2008).

Peoples' minds wander over diverse topics, including concerns and events in the past, present, and future, as well as unrealistic fantasies (Klinger, 1978). A previous study (Sahakyan & Kelley, 2002) reported that thoughts similar in content to some daydreams could impair memory for newly learned information. That study developed what we call the *diversion paradigm*, in which participants study a list of items (List 1), engage in diversionary thought, and then study a second list of items (List 2). The diversions included content similar to daydreams about the past such as imagining being back in one's childhood home or to fantasies such as imagining what one would do if invisible (e.g., Sahakyan & Delaney, 2003; Sahakyan & Kelley, 2002). In these studies, participants received a free-recall test, and those in the diversionary-thought

Corresponding Author:
Peter F. Delaney, Department of Psychology, University of North Carolina at Greensboro, P.O. Box 26170, Greensboro, NC 27602-6170
E-mail: p_delane@uncg.edu

condition tended to forget more items from the first list than participants in the control condition, who did not engage in diversionary thought between studying the two lists.

The diversion paradigm consistently produced forgetting in studies of children (Aslan & Bäuml, 2008), young adults (Delaney & Sahakyan, 2007; Klein, Shiffrin, & Criss, 2007; Pastötter & Bäuml, 2007; Sahakyan & Delaney, 2003; Sahakyan & Kelley, 2002), and older adults (Sahakyan, Delaney, & Goodmon, 2008). The *context-change account* of directed forgetting advanced by Sahakyan and Kelley explains the effects of this paradigm. The context-change account proposes that shifting one's thoughts to something different such as a diversionary thought sets up a new mental context in which subsequent items are encoded. During the test, the new context better matches the List 2 learning context than the List 1 learning context, resulting in forgetting of List 1 items—an effect conceptually similar to the forgetting caused by changing physical location (see Smith & Vela, 2001, for a review). Consistent with this account, mentally reinstating the original context at the time of the test reduced the forgetting caused by diverting participants' thoughts. Additionally, list items that are assumed by formal memory models to have greater contextual information stored in their memory trace are more vulnerable to changes of context between study and test than items with less contextual information in their memory trace (Sahakyan, Delaney, & Waldum, 2008).

Sahakyan and Kelley (2002) originally developed the diversion paradigm to explain how participants in list-method directed-forgetting studies comply with an instruction to forget some recently studied items. Many participants in the 2002 study informally reported distracting themselves with an irrelevant thought, often by thinking about autobiographical memories. In fact, the diversion paradigm in many ways produces behavioral results indistinguishable from the list-method directed forgetting technique. Both techniques produce forgetting of List 1 items relative to a control condition (Sahakyan & Kelley, 2002), in both older and younger adults (Sahakyan, Delaney, & Goodmon, 2008) and in children (Aslan & Bäuml, 2008). Both interact with working memory capacity in a similar manner (Delaney & Sahakyan, 2007). In addition, each technique requires new learning to take place in order to produce forgetting (Pastötter & Bäuml, 2007), and each results in similar serial-position effects in recall (Sahakyan & Foster, 2009).

Context change is often invoked as an explanation of why people forget over time (e.g., Estes, 1950, 1955; Mensink & Raaijmakers, 1988). People encode events in a specific physical environment, time, and socioemotional context. These contextual features are encoded along with the event that is in the focus of attention, and they serve as retrieval cues during recall (e.g., Anderson & Bower, 1972; Dennis & Humphreys, 2000; Estes, 1955; Gillund & Shiffrin, 1984; Hintzman, 1988; Howard & Kahana, 2002). However, over time, context gradually drifts as people encounter new environments, meet new people, and learn new things. This drift in context over time makes the current context a less efficient retrieval cue for more distant memories, and results in forgetting of past events. Hence, according to context theories, people forget not because of the passage of time per se, but rather because of the drift in context, which correlates with the passage of time. Some contextual features change more rapidly than others, making context change a graded process rather than an all-or-nothing process. Therefore, we propose that some diverting thoughts may cause a greater change in context than other thoughts, thereby producing greater memory impairment.

The research presented here focused on mental travel in space and time. Real changes in environmental context (caused by moving from one physical location to another) have been studied for decades and are known to produce forgetting (see Smith & Vela, 2001, for a review). Mentally reinstating the original context circumvents the negative effects of such contextual changes (e.g., Smith, 1979), which indicates that people can exert some control over context, via the power of imagination. Memory can mentally immerse people in the context of places in which they are not physically present. For example, if a novel's protagonist moves to a new physical location, readers have difficulty remembering objects located in the protagonist's previous location (Radvansky & Copeland, 2006). This finding implies that even imagined changes of physical location can affect memory.

We therefore propose that when people imagine an event, they mentally travel to and immerse themselves in the context of that event. Consequently, a diverting imagined event can disrupt and change one's mental context, creating a contextual mismatch with ongoing reality. Furthermore, the degree of forgetting should depend on how different the current context is from the imagined context. We hypothesize that thinking about some distant time or place, such as one's childhood or a vacation to Jamaica, may cause greater forgetting than thinking about a recent event or nearby place. In our experiments, we varied the distance in time and space of retrieved autobiographical memories. In Experiment 1, we varied how much time had elapsed since an imagined place had been visited. In Experiment 2, we varied how far an imagined place was from the current location. We found that participants forgot more of the studied list items when the events were temporally or spatially more distant from the current time and place.

Experiment 1

In earlier studies (e.g., Sahakyan & Delaney, 2003; Sahakyan, Delaney, & Goodmon, 2008; Sahakyan & Kelley, 2002), we assigned participants two lists of items to memorize and asked them to think about their childhood home in between learning the first and the second list. Participants who engaged in the diversionary thought showed less recall of the first list compared with a control group. In this experiment, we again asked participants to remember a place, but we manipulated whether they thought of a place they had visited within the past few

hours (their own house) of a place they had visited weeks ago (their parents' house).

Method

Participants. Participants were 138 Florida State University and University of North Carolina at Greensboro (UNCG) students who participated for course credit. Participants who lived at their parents' home or who had never lived there were excluded from the study.

Materials. The materials included two lists, each with 16 unrelated English nouns (from Sahakyan & Goodmon, 2007). Each list served as List 1 and as List 2 an equal number of times.

Procedure. Participants were instructed to study two lists of words for a memory test. The words appeared individually in the center of a screen at a rate of 5 s/word, with a 500-ms blank screen between words. Between studying List 1 and List 2, participants performed one of three tasks for 45 s. In the control condition, participants read aloud a passage on psychology as a science (taken from an introductory psychology textbook). They were told to ignore content and to read as fast as possible, because we were interested in measuring their reading speed. Participants in the near-change condition were asked to think about the house they currently lived in, imagine themselves there, and draw the house. Participants in the far-change condition received the same instructions as those in the near-change condition, except that the instructions referred to their parents' home.

After participants studied the second list of words, they performed an arithmetic filler task for 90 s. Finally, all participants performed a written free-recall test, with 60 s devoted to the recall of each list. Participants used a separate sheet of paper for each list, and List 1 was always tested first (to prevent output interference). At the end of the session, participants in the far-change condition were asked how many weeks had elapsed since they had visited their parents' home and how many years they had lived there. Two participants neglected to answer the latter question. Participants in the near-change condition were asked how many hours had elapsed since they had been home and how many months they had been living there. On average, participants had visited their own house 2.1 hours earlier, and their parents' house 5.1 weeks earlier.

Results and discussion

Figure 1 shows the mean proportions of List 1 words recalled in each experimental condition: near-change, far-change, and control. A one-way analysis of variance (ANOVA) on the proportion of List 1 items recalled produced a significant main effect of condition, $F(2, 135) = 5.75$, $MSE = 0.012$, $p < .01$, $\eta^2 = .079$. Participants in the far-change condition showed significant forgetting compared with both those in the control condition, $t(90) = 3.40$, $p < .001$, and those in the near-change condition, $t(90) = 2.12$, $p < .05$. However, the near-change and control groups did not differ, $t(90) = 1.23$, $p = .22$. The proportion of List 2 words recalled did not depend on condition, $F < 1$ (far-change condition: $M = .21$, $SD = .11$; near-change condition: $M = .25$, $SD = .13$; control condition: $M = .23$, $SD = .13$).

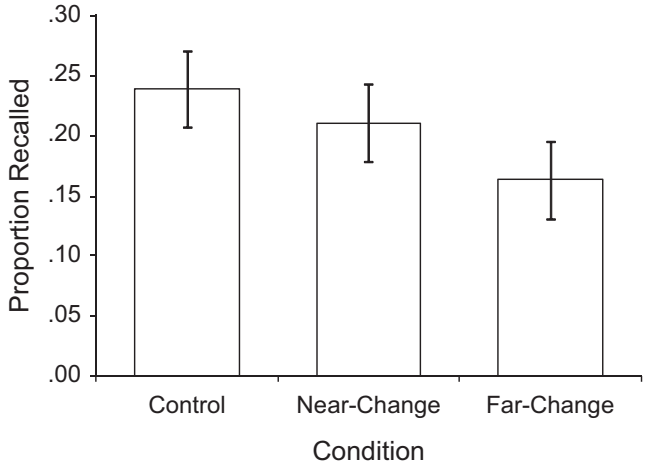

Fig. 1. Mean proportion of List 1 words recalled as a function of condition in Experiment 1. Error bars represent 95% confidence intervals.

If thinking about events disrupts context more the longer ago those events occurred, then people who visited their parental home long ago should have shown more forgetting than those who visited their parental home more recently. As we predicted, in the far-change condition, the greater the number of weeks that had passed since participants visited their parents' house, the fewer words they recalled from List 1, Spearman's $\rho(42) = -.43$, $p < .005$. Figure 2 presents a scatter plot (with a best-fitting regression line) that shows this

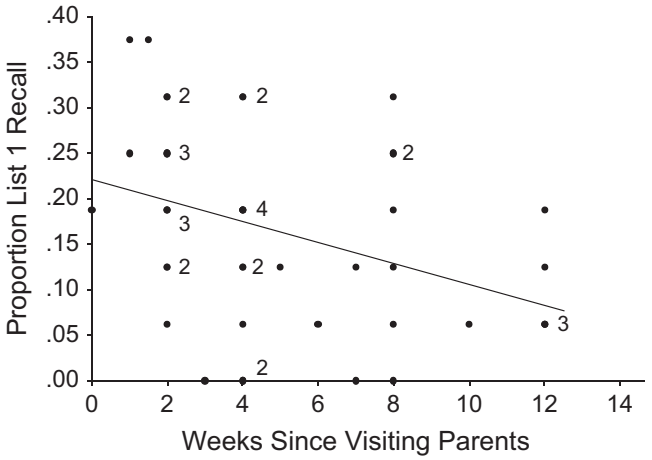

Fig. 2. Scatter plot (with a best-fitting regression line) showing the proportion of List 1 items that participants in the far-change condition of Experiment 1 recalled as a function of the number of weeks since their last visit to their parents' house. The numbers in the plot indicate multiple data points at the same location.

association. We calculated a nonparametric correlation because students usually gave us a round number of weeks, which means they may have treated the measure as an ordinal instead of an interval scale. However, the correlation did not change when we calculated the parametric Pearson's *r* using the same data.

Experiment 2

Experiment 2 involved participants who had recently taken a vacation. The near-change group had taken a trip within the United States, whereas the far-change group had taken an international trip. In this experiment, we wanted to determine whether thinking about a previous longer-distance trip would result in more forgetting than thinking about a shorter-distance trip.

Method

Participants. An online scheduling system was used to recruit 116 UNCG students who had taken a vacation trip outside of North Carolina within the previous 3 years. International travelers were recruited by asking for participants who had vacationed outside the United States within the past 3 years. International exchange students were excluded from the study. Participants were randomly assigned to conditions, with two exceptions. Participants who indicated that they had taken an international trip were assigned only to the far-change or the control group, and correspondingly, participants who had taken a domestic trip were assigned only to the near-change or the control group.

Materials. The materials included two lists, each with 15 unrelated English nouns. Each list served equally often as List 1 and as List 2.

Procedure. We first asked participants where they had traveled, and with whom. Participants were then asked to study two lists of words for a later memory test. Words appeared at the center of a screen at a rate of 5 s/word. Between studying List 1 and List 2, participants engaged in one of the following tasks for 90 s. In the control condition, they performed a two-digit multiplication task as quickly as they could on a sheet of paper. Participants in the near-change condition were asked to imagine their vacation within the United States (but outside of North Carolina) and to describe what it looked, felt, and smelled like. Participants in the far-change condition received the same instructions as those in the near-change condition, except that the instructions referred to their international vacation. After studying List 2, participants performed an arithmetic filler task for 90 s. Finally, all participants received a written free-recall test and devoted 60 s to the recall of each list. As in Experiment 1, List 1 was always tested first, and each list was recalled on a separate sheet of paper.

Results and discussion

Figure 3 shows the mean proportions of List 1 words recalled in each condition: control, near-change, and far-change. A one-way ANOVA on the proportions of List 1 words recalled revealed a significant main effect of condition, $F(2, 113) = 14.42$, $MSE = 0.022$, $p < .001$, $\eta^2 = .20$. Participants in the control condition recalled more List 1 words than those in the near-change condition, $t(74) = 2.41$, $p < .05$, who in turn recalled more words than participants in the far-change condition, $t(74) = 2.90$, $p < .01$. Thus, thinking about an international vacation was associated with greater recall impairment than thinking about a domestic vacation, in accordance with our context hypothesis. The proportion of List 2 words recalled did not depend on condition, $F(2, 113) = 1.73$, $MSE = 0.025$. The mean proportion of List 2 words recalled was .27 ($SD = .14$) in the far-change condition, .30 ($SD = .16$) in the near-change condition, and .33 ($SD = .17$) in the control condition.

We used Globefeed's online distance calculator (http://distancecalculator.globefeed.com) to estimate how far participants' vacation destinations were from Greensboro, North Carolina, in miles. When participants did not provide a city name, we chose the most popular tourist destination (usually the largest city) in the state or country indicated. The near-change group traveled significantly fewer miles ($M = 648$ miles, $SD = 845$ miles) than the far-change group did ($M = 3{,}016$ miles, $SD = 2{,}440$ miles), $t(74) = 5.53$, $p < .001$. For the combined near- and far-change conditions, the correlation between distance in miles and List 1 recall was significant, $r(74) = -.27$, $p < .05$ (Fig. 4). Therefore, thinking about travel to a farther destination was associated with more forgetting.

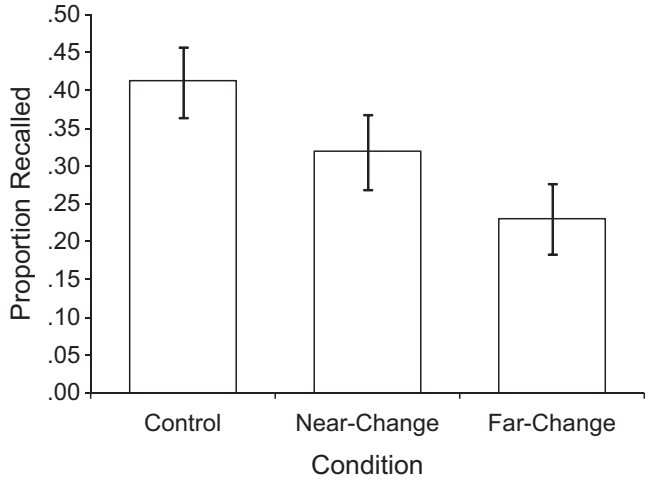

Fig. 3. Mean proportion of List 1 words recalled as a function of condition in Experiment 2. Error bars represent 95% confidence intervals.

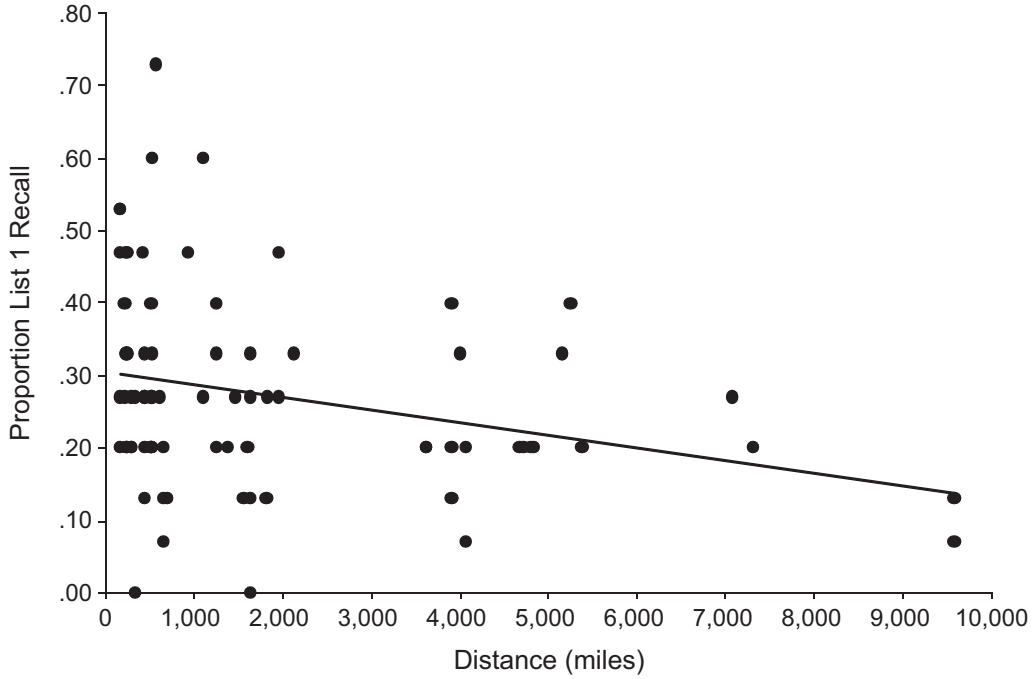

Fig. 4. Scatter plot (with a best-fitting regression line) showing the proportion of List 1 items that participants in Experiment 2 recalled as a function of the distance they traveled to their vacation destination.

General Discussion

We conducted two experiments using the diversion paradigm (Sahakyan & Kelley, 2002) and showed that more contextually distant daydreaming resulted in more forgetting of recently learned items. In Experiment 1, thinking about one's parents' house caused more forgetting than thinking about one's current house, and the amount of forgetting depended on how long ago the house was last visited. In Experiment 2, daydreaming about an international vacation resulted in more forgetting than daydreaming about a domestic vacation.

The manipulations of near and far contexts in Experiments 1 and 2 were not pure manipulations of time (Experiment 1) or distance (Experiment 2), but probably created a combination of temporal, spatial, and conceptual distance from the experimental context. For example, whereas Experiment 1 manipulated time, the distance from the experimental location to the student's apartment was also typically shorter than the distance to his or her parent's home. In addition, participants enacted different roles in their own and their parents' homes. Therefore, time provided a useful metric of context change, but was not the only dimension on which context varied. We propose a context-change explanation of the effects on memory of the mental travel through time and space that occurs during daydreaming: The more that one's mental context is changed by daydreaming, the more difficult it becomes to access what one has just experienced.

Autobiographical memories vary in a number of ways, including degree of vividness and emotionality. For example, the change in cultural context one would experience through an international trip is likely to be much greater than the change one would experience on a trip to a nearby state. However, such properties of autobiographical memories represent intrinsic features of those memories that contribute to their contextual distinctiveness. Identifying dimensions other than time and distance that influence the disrupting effects of daydreams on memory will be an important focus of future research in this area. Dimensions such as functional context and social context, which apparently play a role in limiting the transfer of training (Barnett & Ceci, 2002), could also be salient dimensions of change in mental context.

All studies demonstrating that daydreams produce rapid forgetting have involved participants imagining themselves elsewhere. Therefore, the involvement of the self may be critical for obtaining rapid context-based forgetting. Cognitive neuroscience research has identified a set of neural circuits involved in self-projection and memory (Buckner, Andrews-Hanna, & Schacter, 2008) that become highly active during mind wandering (Mason et al., 2007). This default system involves medial temporal regions of the brain associated with episodic memory, as well as medial frontal regions involved in considering the perspective of another person, retrieving distant autobiographical events, and imagining a future self. It appears that the types of events involved in the default system during daydreaming are remarkably similar to the kinds of events that produced forgetting.

An additional practical implication of our research is that it will be difficult to obtain forgetting effects using the methods outlined in this article with undergraduate populations at commuter colleges, because these students often visit their parents

daily. Our results explain why one might also observe time-of-semester effects in similar studies, as students usually visit their parents at the start of the semester (i.e., thinking about their parents' house would cause students to experience different context change over the course of a semester).

Are the effects we observed identical to those that would be produced by spontaneous daydreaming? The daydreams in our study were produced on demand, and it is possible that spontaneous daydreaming would not cause forgetting. However, the spontaneous self-distracting daydreams that people generate during directed-forgetting tasks appear to produce forgetting comparable to that resulting from the induced daydreams in the diversion paradigm. Nonetheless, future research should use an experience-sampling procedure (which captures daydreaming in natural contexts) to test whether spontaneous daydreaming, which seems effortless, also produces forgetting (e.g., Kane et al., 2007).

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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