

The Reminiscence Bump Without Memories: The Distribution of Imagined Word-Cued and  
Important Autobiographical Memories in a Hypothetical 70-Year-Old

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## Abstract

The *reminiscence bump* is the disproportionate number of autobiographical memories dating from adolescence and early adulthood. It has often been ascribed to a consolidation of the mature self in the period covered by the bump. Here we stripped away factors relating to the characteristics of autobiographical memories *per se*, most notably factors that aid in their encoding or retention, by asking students to generate imagined word-cued and imagined ‘most important’ autobiographical memories of a hypothetical, prototypical 70-year-old of their own culture and gender. We compared the distribution of these fictional memories with the distributions of actual word-cued and most important autobiographical memories in a sample of 61-70-year-olds. We found a striking similarity between the temporal distributions of the imagined memories and the actual memories. These results suggest that the reminiscence bump is largely driven by constructive, schematic factors at retrieval, thereby challenging most existing theoretical accounts.

*Keywords:* autobiographical memory; cultural life script; important memories; reminiscence bump; word-cued memories

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### 1. Introduction

Autobiographical memory is an increasingly popular area of research (Berntsen & Rubin, 2012). One of its hallmarks, *the reminiscence bump*, is poorly understood. It refers to the disproportionate number of autobiographical memories, in middle-aged and older adults, dating from youth and early adulthood (Rubin, Wetzler, & Nebes, 1986). Although the bump is generally assumed to reflect operations of personal reminiscing and meaning-making, the underlying mechanisms have not been clarified. Here we show that it can be found with no involvement of personal memory, thereby challenging most existing accounts.

Researchers have generally employed two broad classes of cueing techniques in probing for the distribution of autobiographical memories over the lifespan, the *cue word method* and the *important memory method*. In the cue word method, participants are asked to recall autobiographical memories in association to cue words (Crovitz & Schiffman, 1974; for subsequent studies employing this technique to look at the bump, see, e.g., Janssen & Murre, 2008; Janssen, Rubin, & St. Jacques, 2011; Koppel & Berntsen, 2016; Rubin & Schulkind, 1997a; Schuman & Corning, 2014; Willander & Larsson, 2006); in the important memory method, participants are asked to recall particularly important memories. The important memory method can take several forms. For instance, participants have been asked to simply report a given number of important autobiographical memories (Cuervo-Lombard et al., 2007; Glück & Bluck, 2007; Rubin & Schulkind, 1997a), or to recall events that they consider particularly central to their life story (Bohn, 2010; Fitzgerald, 1996; Thomsen & Berntsen, 2008).

The theoretically important distinctions between these two classes of cueing techniques concern the retrieval strategies required by each, as well as, relatedly, the

representativeness of the resulting autobiographical memories for an individual's total corpus of autobiographical memories. The cue word method involves an associative search in relation to the relevant cue word, and this association can take any form. Furthermore, the cue word method is intended to yield an unbiased sampling of an individual's autobiographical memories (Crovitz & Schiffman, 1974). A request for important memories, conversely, requires memories with a specific role in the participant's life story, and therefore tends to produce a narrative-based search. The memories produced through the important memory method are naturally not intended to be representative of all of an individual's autobiographical memories.

Although this consideration is often overlooked, both the attained bump and the broader distribution of autobiographical memories are not identical across these two methods. First, the bump is smaller in the cue word method (Fitzgerald, 1988; Fromholt et al., 2003; Rubin & Schulkind, 1997a). Second, word-cued memories, but not important memories, exhibit a retention function, which can be described as a power function whereby the number of memories per hour can be plotted as a function of the amount of time elapsed since the event (Rubin & Schulkind, 1997a). The retention function for word-cued memories is characterized by initially rapid forgetting, which then slows over time. One consequence of this retention function is that the distribution of word-cued memories – but, again, not important memories – is marked by a disproportionately large number of recent memories.

Third, and most pertinently for our current purposes, the temporal location of the bump is earlier in the cue word method. Rubin and Schulkind (1997a) first empirically demonstrated this disparity in the location of the bump, and recently we have followed up on their findings in a review, wherein we averaged across all relevant studies to date in isolating the mean beginning and endpoints of the bump for word-cued memories and important memories, respectively, as reported in the individual studies (Koppel & Berntsen, 2015). We

found that the mean range of the bump in word-cued memories is from 9 to 23 years of age, while, for important memories, the corresponding range is from 15 to 28. Building on this finding, Koppel and Rubin (2016) argued that, when five-year age bins (e.g., 0-5 years, 6-10 years, etc.) are employed in plotting the data, rather than the less precise 10-year bins (e.g., 0-10 years, 11-20 years, etc.), the bump in word-cued memories appears to extend back to the beginning of the full offset of childhood amnesia.

The disparate temporal locations of the bump hold important implications for theoretical accounts of the effect (see Koppel & Berntsen, 2015). Specifically, they suggest that the bump is largely driven by processes operative at retrieval, inasmuch as these disparate locations are effectively produced by manipulating the retrieval strategy employed by participants. Therefore, they are evidence in favor of a retrieval-based account, and thus run counter to most existing accounts, which emphasize factors at encoding and retention. The most prominent of this class of theories is probably the *identity formation account*, according to which the bump is due to the consolidation of the self and the formation of a mature adult identity in the period covered by the bump (e.g., Conway & Pleydell-Pearce, 2000; Fitzgerald, 1988, 1996). Other theories stressing factors at encoding and retention include the *cognitive account*, according to which the bump is due to the novelty of events of the bump period, including the occurrence of many first-time events (Robinson, 1992; Rubin, Rahhal, & Poon, 1998), and the *cognitive abilities account*, according to which the bump is due to the putatively optimal cognitive and neurological functioning evident in the bump period (Janssen, Kristo, Rouw, & Murre, 2015; Rubin et al., 1998).

The *life script account* represents an alternative to this class of theories (Berntsen & Rubin, 2004). The life script account starts with the premise that individuals possess culture-based general knowledge about the most important events in a typical life and when they are expected to occur. This cultural life script is then held to serve as a cognitive schema that

guides the retrieval of important autobiographical memories. Crucially, the life script account posits that it is the cultural significance assigned to life script events that renders them especially accessible in recall, rather than factors specific to the individual. There is substantial evidence that cultural life scripts help to structure the retrieval of autobiographical memories of important and emotional events (Berntsen & Bohn, 2010; Berntsen & Rubin, 2004; Bohn, 2010; Dickson, Pillemer, & Bruehl, 2011; Rubin & Berntsen, 2003), as well as the events in fictional life narratives (Koppel & Berntsen, 2014).

To be sure, knowledge of life scripts may also contribute to the encoding and rehearsal of an event, by endowing certain personal events (e.g., one's wedding) with a culturally shared significance. Indeed, many life script events are expected, prepared for, and assigned a specific meaning before they even take place in the individual life course (Berntsen & Rubin, 2004). However, the life script account is distinct from the other accounts in that it explicitly emphasizes retrieval processes as well as represents a collective and schema-based explanation of the bump, rather than an individualistic and memory-based account.

Another distinction between the life script account and other theories of the bump is that the life script account was explicitly restricted to the retrieval of important memories. Life scripts were not expected to govern the retrieval of memories sampled through more random and associative cueing, such as word-cued memories, because this type of cueing is unlikely to activate culturally shared schemata for significant transitional events (Berntsen and Rubin, 2004). The greater frequency of life script events in important memories than word-cued memories, and the correspondingly larger role the life script plays in the bump for important memories, has been borne out in subsequent empirical findings (Berntsen & Bohn, 2010; Koppel & Berntsen, 2016). For instance, in a within-subjects design employing university students as participants, Berntsen and Bohn (2010) found that 71% of participants'

important memories represented life script events, compared to only 20% of their word-cued memories.

### 1.1. Overview of the Current Studies

Here we pursued the construction hypothesis represented by the life script account even further, thereby extending it beyond the life script account. Specifically, the aim of the present research was to test the overarching premise that the individual reminiscence bumps in both word-cued and important memories are each largely driven by schema-based constructive processes taking place at retrieval, rather than qualities inherent to autobiographical memories in and of themselves. We tested this premise by first, in Study 1, collecting word-cued and important memories from an online sample of US adults aged 61 to 70 years old. Then, in Study 2, we asked Danish students to generate imagined word-cued and important autobiographical memories of a hypothetical, prototypical 70-year-old of their own culture and gender; this procedure strips away factors relating to the characteristics of autobiographical memories *per se*, most notably factors that aid in their encoding, leaving participants reliant on general schematic processes. By comparing both the respective bumps and broader distributions we attained for word-cued and important memories, across the actual versus imagined memories, we were able to test whether the schematic processes involved in the imagined memory task are sufficient, absent encoding- and retention-related processes, to produce temporal distributions resembling those found in autobiographical memory proper.

We conclude on three methodological notes. First, it should be underscored that the key purpose of Study 1 was to replicate the specific distributions that have been attained for word-cued and important autobiographical memories in the literature to date, including, most notably, the differential locations of the bump attained through each method (see Koppel & Berntsen, 2015). These data would then serve as a reference point to use as a comparison for

the temporal distributions of the imagined memories we collected in Study 2. Our core predictions, however, concerned the imagined memories, rather than the actual memories. Therefore, in order to maintain an emphasis on the more critical data of Study 2, we engaged in more extensive coding of the Study 2 data, and discuss it at greater length.

Second, rather than counterbalance the order of the cue word and important memory tasks, we always administered the cue word task first in both studies. We did so because, given that important memories are highly accessible in recall, we believed it was more likely that participants would draw on important memories they had previously produced in generating word-cued memories, rather than the other way around. Word-cueing is a random cueing technique that is expected to be neutral with regard to the content of the memories it yields (Crovitz & Shiffman, 1974). Therefore, administering this task first would be unlikely to bias the subsequent retrieval of important memories. To the extent it would do so, this would work against our hypotheses, by rendering the distributions of the two types of memories more similar.

Third, following from the types of cue words generally used in recent studies on the word-cued bump (e.g., Janssen & Murre, 2008; Janssen et al., 2011; Schuman & Corning, 2014), here we used concrete, imageable object nouns. Less imageable cue words have been found to yield more recent memories (Fitzgerald & Lawrence, 1984; Rubin, 1980; Rubin & Schulkind 1997b), so that using such words would have likely resulted in a later reminiscence bump for the actual memories, and possibly for the imagined memories as well. Furthermore, one would imagine that certain cue words (e.g., *kiss*, *wedding*, or *birth*) would be likely to trigger life script events in both actual and imagined memories, thereby producing a bump that bore more of a resemblance to the bump in important memories. However, using words that are likely to have strong associations to certain events would undermine the central goal of the cue word method, namely, to provide an unbiased sampling

of an individual's corpus of autobiographical memories (Crovitz & Schiffman, 1974). We therefore selected our cue words on the basis of an extensive pool of nouns used in previous research (Rubin, 1980; Rubin & Schulkind, 1997a)

## 2. Study 1

In Study 1 we expected to replicate the distributions that have generally been attained across the literature (see Koppel & Berntsen, 2015, for a review). Thus, we expected the bump for word-cued memories to be located earlier in the lifespan than the bump for important memories. Specifically, given that the bump in word-cued memories has been found to extend back to the offset of childhood amnesia when five-year bins have been employed (Koppel & Rubin, 2016), we predicted that, employing five-year bins, the bump we attained in word-cued memories would commence at age 6 and range up until age 20 or 25. Conversely, for important memories, we expected to find a bump from ages 16 to 30. Likewise following previous findings in autobiographical memory (Rubin & Schulkind, 1997a), we predicted that we would find a retention component in the distribution of word-cued memories, but not important memories.

### 2.1. Method

**2.1.1. Participants.** The data reported here were taken from 42 US-based adults, between the ages of 61 and 70 years old. Thirty-two participants were female (76.2%), and the sample's mean age was 65.3 years ( $SD = 3.0$ ). The participants were recruited over the internet, through a combination of the websites SurveyMonkey – in which case the website recruited participants – and Mechanical Turk. These 42 participants were culled from 51 participants who initially completed the survey, with the other nine participants excluded because, of the seven word-cued and important memories requested of each participant (see below), they left three or more of at least one type of memory blank. This exclusion criterion weeded out participants who rushed through or did not pay sufficient attention to the task.

**2.1.2. Questionnaire and procedure.** The questionnaire and procedure were modeled after the ones employed by Rubin and Schulkind (1997a) to compare the distributions of word-cued and important autobiographical memories. First, participants generated autobiographical memories in association to each of seven cue words. In doing so, they were instructed to give a brief description of the first personal event they thought of in association to each cue word. They were instructed that the event could come from any point in their life, but that it should be a specific event, meaning that it occurred at a specific time and place. After generating all seven memories, participants were then asked to date each event according to their age, in years, at the time of its occurrence.

We selected the cue words from the 124 nouns used as cue words by Rubin and Schulkind (1997a; see also Rubin, 1980). In particular, we chose 42 words, which averaged a 6.0 or more on concreteness, imagery, and meaningfulness in Paivio, Yuille, and Madigan (1968). The cue words are presented in Appendix A. The 42 cue words were divided into six groups of seven words, with each group of cue words presented to one-sixth of the participants. In ordering the cue words, we created a different, random order for each participant.

After dating the word-cued memories, participants were then asked to give a brief description of the seven most important personal events of their lives, with the stipulation again that the events could come from any point in their life, but that they should be specific. As with the word-cued memories, participants were then asked to indicate their age, in years, at the time of each event.

## **2.2. Results and Discussion**

Out of a maximum of 294 memories (42 participants X 7 memories each), the following analyses draw upon 281 word-cued memories and 292 important memories. The missing data is due to 13 word-cued memories and two important memories being left blank,

undated, or dated as occurring over too broad a range of time to be reasonably employed towards the temporal distributions (e.g., between the ages of 12 and 65).<sup>1</sup>

The temporal distributions of the word-cued and important memories are presented in Figure 1. We only plotted the distributions through age 65 because most of the participants had either not reached or not fully lived through the 66-70 age interval. Therefore, plotting the distributions through age 70 would have obscured any increase in the number of recent memories. In the following, we individually examine bump effects and retention components, respectively.

**2.2.1. Bump effects.** For the word-cued memories, the bump skewed even slightly earlier than we had predicted. Though there was a general increase between the ages 0 to 15, we will define the bump as spanning from ages 6 to 10, as this represents the clear peak in the distribution. We tested the statistical significance of the bump by calculating, individually for each participant, the proportion of memories reported within the bump period, and comparing it through a paired-samples *t*-test to the proportion of memories reported within both the preceding and following intervals of the same length (i.e., the preceding and following five years). Insofar as we compared the number of memories per interval, the crucial point here is that the intervals were the same length; in several subsequent comparisons, the intervals being compared were of varying lengths, and in these cases we applied appropriate adjustments to the data. The *t*-test analysis was significant when comparing the 6-10 age interval to the 0-5 interval [ $M_{6-10} = .22$  ( $SD = .21$ ) vs.  $M_{0-5} = .11$  ( $SD = .19$ ),  $t(41) = 2.83$ ,  $p = .007$ ,  $d = .44$ ]. The analysis fell just short of being significant at an alpha level of  $p < .05$  when comparing the 6-10 age interval to the 11-15 interval, though it

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<sup>1</sup> For six word-cued memories, however, participants dated the event as occurring over a narrower range of time (within 10 years). For the purposes of the present analyses, we dated these memories according to the midpoint of this range.

did yield a reasonable effect size [ $M_{6-10} = .22$  ( $SD = .21$ ) vs.  $M_{11-15} = .13$  ( $SD = .15$ ),  $t(41) = 2.00$ ,  $p = .052$ ,  $d = .31$ ]. We further confirmed the bump from 6 to 10 by additionally comparing the proportion of memories reported in this age range to the proportion of memories reported over the ages of 16 to 60, adjusting for the disparity in the two time frames by dividing the number of memories dated as occurring from 16 to 60 by nine. This analysis yielded further support for the presence of a bump from 6 to 10 [ $M_{6-10} = .22$  ( $SD = .21$ ) vs.  $M_{16-60/9} = .05$  ( $SD = .03$ ),  $t(41) = 4.86$ ,  $p < .001$ ,  $d = .75$ ]. We will, then, define the bump in the word-cued memories as occurring from 6 to 10.

For the important memories, consistent with our predictions, we found a later bump from the ages 16 to 30. We tested the statistical significance of the bump through a similar means as for the word-cued memories, that is, by comparing, within each participant, the proportion of memories occurring between the ages 16 to 30 to the proportion of memories occurring between the ages of 0 to 15 and 31 to 45, respectively. This analysis confirmed that we attained a sizable bump [ $M_{16-30} = .51$  ( $SD = .17$ ) vs.  $M_{0-15} = .10$  ( $SD = .15$ ),  $t(41) = 11.58$ ,  $p < .001$ ,  $d = 1.79$ ;  $M_{16-30} = .51$  ( $SD = .17$ ) vs.  $M_{31-45} = .20$  ( $SD = .15$ ),  $t(41) = 7.55$ ,  $p < .001$ ,  $d = 1.17$ ].

As a more direct test of how the respective peaks in word-cued and important memories were unique to each type of memory, rather than extending to the other type of memory, we compared, again within-subjects, the proportion of memories reported in the bump period in each domain to the proportion of memories reported over the same time frame in the other domain. We found that there were significantly more word-cued memories from the ages of 6 to 10 than important memories [ $M_{\text{word-cued memories}} = .22$  ( $SD = .21$ ) vs.  $M_{\text{important memories}} = .03$  ( $SD = .09$ ),  $t(41) = 5.44$ ,  $p < .001$ ,  $d = .84$ ], and, conversely, more important memories from 16 to 30 than word-cued memories, [ $M_{\text{important memories}} = .51$  ( $SD = .17$ ) vs.  $M_{\text{word-cued memories}} = .19$  ( $SD = .17$ ),  $t(41) = 9.19$ ,  $p < .001$ ,  $d = 1.42$ ].

**2.2.2. Retention component.** The most notable manifestation of a retention component in the distribution of either word-cued or important memories would be a disproportionately large number of recent memories. Consistent with our predictions, Figure 1 suggests that word-cued memories demonstrated an increased number of memories over the final 10 years of participants' lives, while, for important memories, there was no such increase. We tested for the statistical significance of any retention component in both the word-cued and important memories by calculating, again within each participant, the proportion of memories reported over the most recent 10 years of each participant's lifespan to that point (e.g., for a 70-year old participant, from ages 61 to 70), and comparing this proportion to the proportion of memories reported in the preceding 10 years (e.g., again for a 70-year-old, from ages 51 to 60). We found a significant retention component for word-cued memories [ $M_{\text{Most Recent 10 Years}} = .16$  ( $SD = .21$ ) vs.  $M_{\text{Preceding 10 Years}} = .06$  ( $SD = .13$ ),  $t(41) = 2.84$ ,  $p = .007$ ,  $d = .44$ ], but not important memories [ $M_{\text{Most Recent 10 Years}} = .10$  ( $SD = .14$ ) vs.  $M_{\text{Preceding 10 Years}} = .10$  ( $SD = .12$ ),  $t(41) = .02$ ,  $p = .99$ ].

### 2.3. Discussion

In Study 1, we largely replicated both the respective bumps and broader life span distributions that prior researchers have attained for word-cued and important autobiographical memories, respectively. Specifically, we found an early bump from ages 6 to 10 for word-cued memories, and a later bump from ages 16 to 30 for important memories. At the same time, we attained a retention component for word-cued memories but not for important memories. The greatest divergence between the distributions we attained and the distributions typically found in the literature is that the bump in word-cued memories we attained here skewed slightly earlier than has generally been the case (Koppel & Berntsen, 2015). Our results for important memories largely paralleled the typical distribution. This

result suggests that, though we always administered the important memory task after the cue word task, any order effects were negligible.

### 3. Study 2

Having attained distributions of word-cued and important memories that are largely similar to the established distributions of autobiographical memories, we now turn to the data for the imagined memories. As we noted in the Introduction, the aim of Study 2 was to test whether the respective distributions of word-cued and important autobiographical memories, including their differing reminiscence bumps, could be replicated in imagined memories. If so, this finding would add important new data to the literature on the reminiscence bump, by demonstrating the central role of constructive processes at the time of retrieval, as opposed to processes at the time of encoding and/or retention (e.g., enhanced encoding and maintenance due to identity formation).

In Study 2 we examined the temporal distributions of word-cued and important memories not in autobiographical memory *per se*, but in a hypothetical 70-year-old. In asking participants to generate imaginary memories, we drew upon a well-established strategy of probing schematic knowledge independent of the recall of actual exemplars of the phenomenon under consideration (Dickson et al., 2011; Rubin & Berntsen, 2003; Rubin & Kontis, 1983; Rubin, Stolzhus, & Wall, 1991; Rubin, Wallace, & Houston, 1993). Following the rationale underlying this type of procedure, in constructing the imagined word-cued and important memories of a hypothetical adult, participants would be reliant on the schematic processes that play a role in generating autobiographical memories.

Our postulation that schematic processes underlie both the bump and the broader distribution of autobiographical memories over the lifespan, and that life scripts in particular structure retrieval of important memories but not word-cued memories, leads to several predictions. First, to the extent that our postulation is correct, we would expect the imaginary

memory task to produce bumps in word-cued and important memories that, respectively, temporally resemble the bumps found in each case in autobiographical memory. We therefore would expect the bump for word cued memories to show an earlier peak than the bump for important memories; more specifically, we again expected the bump in word-cued memories to range from age 6 to age 20 or 25, and the bump in important memories to range from ages 16 to 30. Although the bump we attained for word-cued memories in Study 1 skewed slightly earlier than the range we predicted here for the imagined memories, our prediction is nonetheless in keeping with the overall corpus of studies on the bump in word-cued memories (Koppel & Berntsen, 2015).

Second, a schema-based account of the distribution of autobiographical memories would likewise predict that the imaginary memory task would produce retention components that resemble the retention components found in autobiographical memory (Rubin & Schulkind, 1997a). That is, a schematic account would predict that we should attain a retention component for imagined word-cued memories, but not imagined important memories. Third, consistent with prior findings on the relative frequency of life script events in important memories versus word-cued memories (Berntsen & Bohn, 2010; Koppel & Berntsen, 2016), we predicted that the life script schema, in particular, would underlie the bump we found in important memories, but not word-cued memories.

Conversely, given the stress that competing accounts of the bump place on either the characteristics of memories from the bump period themselves as producing the bump, or the ostensibly heightened ability to encode autobiographical memories at the time of the bump period (for a review, see Koppel & Berntsen, 2015), these accounts would not predict that we should find bumps in imagined memories that temporally resemble the bumps in autobiographical memory proper. The prediction derived from this class of theories would seem to be that the imagination task used in the present study would yield distributions that

differ from the ones found for real autobiographical memories, inasmuch as the encoding processes that these theories posit as contributing towards the distributions of autobiographical memories are absent in the generation of imagined memories.

### **3.1. Method**

**3.1.1. Participants.** We recruited 42 Aarhus University students. The participants completed a paper-and-pencil version of the survey, handed out in group settings. Thirty-three participants were female (78.6%), and the sample's mean age was age 23.3 years ( $SD = 2.2$ ; range = 20-29). Participants received two cinema tickets as compensation.

**3.1.2. Questionnaire and procedure.** The questionnaire and procedure paralleled the ones employed in Study 1, but were modified to address the memories of a hypothetical 70-year-old. First, participants generated the autobiographical memories they imagined a hypothetical, prototypical 70-year-old of their own culture and gender would produce in association to each of seven cue words. The instructions for this task followed from the instructions we utilized in Study 1, but were applied to this hypothetical individual. We used the same pool of 42 cue words as in Study 1 (in Danish translations), with each group of seven words again presented to one-sixth of the participants, and a different, random order of the words created for each participant. As in Study 1, after generating all seven memories, participants were then asked to indicate how old they thought the hypothetical individual would have been, in years, at the time of each event's occurrence.

Participants then gave a brief description of what they imagined the seven most important personal events of this hypothetical person's life would be, following similar instructions as in Study 1. Lastly, participants dated each of these important events according to the imagined age, in years, of the hypothetical individual at the time.

### **3.1.3. Content-coding of the questionnaire.**

**3.1.3.1. Memory specificity.** Given the presumably greater difficulty of generating imagined autobiographical memories, compared to actual autobiographical memories, we wanted to assess whether participants were able to successfully perform this more abstract task. We therefore coded each word-cued and important imagined memory according to whether it was specific or non-specific. Memories were coded as specific if, following the instructions we gave participants, they referred to a discrete event that took place at a particular time and place. An initial coder first coded all memories, with 25% of each type of memory subsequently dual-coded by a second, independent coder. Reliability was good in both cases, with agreement of greater than 90% for both word-cued and important memories.

**3.1.3.2. Life script events.** In order to examine the prediction that the life script would underlie the bump we found in imagined important memories, but not in imagined word-cued memories, we coded each word-cued and important memory according to whether it represented one of the 35 events Berntsen and Rubin (2004) attained as comprising the Danish life script. An initial coder again first coded all memories, with 25% of each type of memory subsequently dual-coded by a second, independent coder. Reliability was again good in both cases, with agreement of greater than 90% for each type of memory.

## **3.2. Results**

Out of a maximum of 294 memories, the following analyses draw upon 292 word-cued memories and 294 important memories. The participants were generally surprisingly good at producing autobiographical-like memories for the fictitious 70-year-old. Examples of the imagined memories (translated into English) are illustrated in Appendix B. In the following, we compare our findings for the imagined versus actual memories. We look first at the specificity of the imagined memories, before turning to the key question of their temporal distributions.

**3.2.1. Memory specificity.** Across participants, a mean of 72.0% ( $SD = 29.4\%$ ) of word-cued memories were coded as specific; the corresponding mean was 92.9% ( $SD = 13.5\%$ ) for important memories. The percentage of specific word-cued memories we attained is similar to the percentages typically found in autobiographical memory tasks that solicit specific memories (see discussion in Mace, Clevinger, & Martin, 2010). Thus, participants were able to follow the instructions at rates similar to the rates found in studies on autobiographical memory proper. We included both specific and non-specific memories in the following analyses, as, in prior studies on the reminiscence bump, there generally has been no indication that the researchers discarded non-specific memories.

**3.2.2. Temporal distributions.** The temporal distributions of the imagined word-cued and important memories are presented in Figure 2. The distributions are plotted alongside the parallel distributions that we attained in autobiographical memory in Study 1, in order to facilitate comparisons of the imagined versus actual memories.

As the figure indicates, despite slight differences in the precise distributions across the imagined versus actual memories, the distributions were overall quite similar: As with the actual memories, the distributions of the imagined memories were characterized by an earlier bump for word-cued memories and a later bump for important memories, along with a disproportionately large number of memories towards the end of the lifespan for word-cued memories, but not important memories. We measured the extent of this similarity by ranking, separately for each individual type of memory (i.e., imagined word-cued memories, actual word-cued memories, imagined important memories, and actual important memories), each of the five-year intervals represented in Figure 2 according to the number of memories reported therein.<sup>2</sup> We then computed Spearman rank correlations between these rankings for

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<sup>2</sup> In this analysis, unlike in Figure 2, we did employ the data from the 66-70 age interval for the actual memories from Study 1. However, we adjusted for the fact that most participants had not lived through the

the imagined word-cued memories and actual word-cued memories, as well as between the imagined important memories and actual important memories, respectively. We found a strong and statistically significant correlation in each case (for the word-cued memories:  $R = .68$ ,  $p = .007$ ; for the important memories:  $R = .79$ ,  $p = .001$ ;  $N = 14$  in both cases, reflecting the number of five-year intervals from ages 0 to 70).

Insofar as the purpose of Study 2 was effectively to test whether the distributions of the actual memories in Study 1 could be predicted from the distributions of the imagined memories, we were additionally interested in testing this prospect. Towards that end, then, we ran a separate linear regression for the word-cued and important memories, respectively. In each regression analysis, the unit of analysis was the 14 age bins illustrated in Figure 2. In each case, the number of imagined memories in each of the 14 five-year age bins in Figure 2 served as the independent variable, and the number of actual memories in the same bins (with, again, the number of memories in the 61-65- and 66-70-year bins adjusted to account for most of the participants not having fully lived through this decade) served as the dependent variable. We expected and attained a linear relation between the number of memories in each bin across the imagined versus actual memories, as, for both the word-cued and important memories, the number of imagined memories in each bin significantly predicted the number of actual memories in that bin [word-cued memories:  $F(1, 12) = 6.75$ ,  $p = .023$ ,  $R^2 = .36$ ,  $N = 14$ ; important memories:  $F(1, 12) = 103.37$ ,  $p < .001$ ,  $R^2 = .90$ ,  $N = 14$ ].

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entirety of the 61-70 decade. In doing so, we followed a procedure described in greater detail in Berntsen and Rubin (2002), whereby we extrapolated from the number of memories reported over this final decade to calculate how many memories participants would have been expected to report over this decade had they fully lived through it. For the purposes of this projection, we assumed that participants would have reported an equal number of memories in each of the 61-65 and 66-70 age intervals.

In breaking down the distributions of the imagined memories in more detail, we first look individually at bump effects and retention components, respectively. We then turn to analyses of the frequency and individual distributions of life script and non-life-script events, in order to test our prediction that the life script schema would underlie the bump in important memories, but not word-cued memories.

**3.2.2.1. Bump effects.** Based on the distributions in Figure 2, we would place the bump in the imagined word-cued memories as from ages 6 to 25, and the bump in the imagined important memories as from ages 16 to 30. Each of these bumps is consistent with our predictions. We tested the statistical significance of each bump through the same within-subjects calculation as in Study 1. Likewise similar to our treatment of the analogous case in Study 1, in comparing the proportion of word-cued memories over the 6-25 interval to the proportion of word-cued memories over the 0-5 interval, we adjusted for the disparity in the two time frames by dividing the proportion of memories in the 6-25 interval by four. These analyses yielded a significant bump for both word-cued and important memories [word-cued memories:  $M_{6-25/4} = .14$  ( $SD = .06$ ) vs.  $M_{0-5} = .03$  ( $SD = .07$ ),  $t(41) = 8.09$ ,  $p < .001$ ,  $d = 1.25$ ;  $M_{6-25} = .55$  ( $SD = .26$ ) vs.  $M_{26-45} = .17$  ( $SD = .16$ ),  $t(41) = 7.23$ ,  $p < .001$ ,  $d = 1.12$ ; important memories:  $M_{16-30} = .49$  ( $SD = .16$ ) vs.  $M_{0-15} = .09$  ( $SD = .11$ ),  $t(41) = 12.72$ ,  $p < .001$ ,  $d = 1.96$ ;  $M_{16-30} = .49$  ( $SD = .16$ ) vs.  $M_{31-45} = .14$  ( $SD = .14$ ),  $t(41) = 9.13$ ,  $p < .001$ ,  $d = 1.41$ ].

As with the distributions in Study 1, we again tested, within-subjects, that the respective peaks for both word-cued and important memories were unique to each type memory. We found that, similar to the actual memories, there were significantly more word-cued memories from the word-cued bump period of ages 6 to 25 than important memories [ $M_{\text{word-cued memories}} = .55$  ( $SD = .26$ ) vs.  $M_{\text{important memories}} = .41$  ( $SD = .24$ ),  $t(41) = 3.51$ ,  $p = .001$ ,  $d = .54$ ], and more important memories from the important memory bump period of 16 to 30

than word-cued memories [ $M_{\text{important memories}} = .49$  ( $SD = .16$ ) vs.  $M_{\text{word-cued memories}} = .34$  ( $SD = .23$ ),  $t(41) = 4.07$ ,  $p < .001$ ,  $d = .63$ ].

Analyses of the distributions attained for each individual cue word revealed that the bump in the word-cued memories was not driven by a subset of words, but, rather, that we broadly attained a bump for most of the 42 words we used. Overall, 55.1% of the word-cued memories were dated within the bump period of 6 to 25 years of age. Each of the individual words were seen by 7 participants (though, in the case of *salad* and *ship*, only six usable memories were generated). Of the 42 words, at least 3 of the 7 (or 6) generated memories (i.e., 42.9% of the memories, or 50.0% of the memories for *salad* and *ship*) were within the bump period for 35 (i.e., 83.3%) of the words.<sup>3</sup>

**3.2.2.2. Retention component.** Again, the most notable consequence of a retention component would be a disproportionately large number of memories over the final period of the hypothetical individual's life. Figure 2 suggests that, as we had expected, there was an increase in the number of imagined word-cued memories over the final 15 years of the hypothetical individual's life (i.e., ages 56 to 70), but no parallel increase in imagined important memories. We tested for the statistical significance of any retention component in each domain through the parallel method as in Study 1, yielding a significant retention component for word-cued memories [ $M_{56-70} = .20$  ( $SD = .26$ ) vs.  $M_{41-55} = .07$  ( $SD = .10$ ),  $t(41) = 2.87$ ,  $p = .006$ ,  $d = .44$ ], but not important memories, [ $M_{56-70} = .17$  ( $SD = .15$ ) vs.  $M_{41-55} = .14$  ( $SD = .11$ ),  $t(41) = 1.21$ ,  $p = .23$ ].

**3.2.2.3. The frequency and temporal distributions of life script and non-life-script events.** Consistent with prior findings for actual autobiographical memories (Berntsen & Bohn, 2010; Koppel & Berntsen, 2016), a considerable majority of the imagined important

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<sup>3</sup> We could not conduct this analysis for the word-cued memories in Study 1 because the online survey did not permit us to trace each word-cued memory back to the word that had cued it.

memories were comprised of life script events, specifically, across participants, 73.1% ( $SD = 15.3\%$ ) of the memories. As we expected, these life script events largely drove the bump from 16 to 30 in the overall distribution. In these events taken individually, though, the increase was concentrated in the 21-30 range, as tested through the same within-subjects analysis we previously employed in testing for bump effects [ $M_{21-30} = .44$  ( $SD = .20$ ) vs.  $M_{11-20} = .16$  ( $SD = .16$ ),  $t(40) = 6.09$ ,  $p < .001$ ,  $d = .95$ ;  $M_{21-30} = .44$  ( $SD = .20$ ) vs.  $M_{31-40} = .08$  ( $SD = .13$ ),  $t(40) = 8.10$ ,  $p < .001$ ,  $d = 1.26$ ].<sup>4</sup>

In the case of the imagined word-cued memories, and likewise consistent with the autobiographical memory literature (Berntsen & Bohn, 2010; Koppel & Berntsen, 2016), relatively few memories were comprised of life script events ( $M = 25.0\%$ ;  $SD = 16.8\%$ ). Moreover, the bump for these memories held when looking at non-life-script events taken alone, again adjusting for the bump period being four times longer than the preceding age interval of 0-5 years [ $M_{6-25/4} = .13$  ( $SD = .07$ ) vs.  $M_{0-5} = .03$  ( $SD = .08$ ),  $t(40) = 5.98$ ,  $p < .001$ ,  $d = .93$ ;  $M_{6-25} = .54$  ( $SD = .28$ ) vs.  $M_{26-45} = .17$  ( $SD = .19$ ),  $t(40) = 6.10$ ,  $p < .001$ ,  $d = .95$ ]. As we anticipated, then, the bump we attained for word-cued memories cannot be attributed to the life script.

### 3.3. Discussion

We found that the temporal distributions of imagined word-cued and important autobiographical memories bore striking resemblance to the distributions found in autobiographical memory proper, with respect both to the corpus of literature on word-cued and important memories to date (as reviewed in Koppel & Berntsen, 2015), as well as the

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<sup>4</sup> The degrees of freedom were depressed in the analyses on life script and non-life-script events taken individually because we only calculated the relevant means for participants who had at least three of the relevant type of imagined memory (i.e., memories of non-life-script events or memories of life script events, respectively). In each case, this criterion excluded one participant.

autobiographical memory data we collected as a reference point in Study 1. Similar to the distribution of actual word-cued autobiographical memories over the lifespan, the distribution of imagined word-cued memories was characterized by an early reminiscence bump from ages 6 to 25, as well as a retention component that was manifested by an increase in the number of memories in the last 15 years of the hypothetical individual's life. The distribution of imagined important memories, conversely, featured a later bump from ages 16 to 30 and no retention component, also in line with the distribution of actual important autobiographical memories. The most notable divergence between the distributions we attained for the imagined versus actual memories is that the bump in the actual word-cued memories skewed slightly earlier than the bump in the imagined word-cued memories. If anything, however, it is our data for the actual word-cued memories that deviate slightly from the aggregate findings in the literature to date (Koppel & Berntsen, 2015).

This similarity between the distributions of the actual memories we collected in Study 1 and the imagined memories we collected in Study 2 held despite the consideration that the procedure and groups we employed across the two studies differed slightly from each other in two potentially relevant respects. First, the imagined memory data were collected via a paper-and-pencil questionnaire, whereas the actual memory data were collected over the internet. Second, the imagined memory data were collected from a Danish sample, whereas the actual memory data were collected from a US sample. Therefore, the similarity between the distributions of imagined memories and actual autobiographical memories is robust.

#### **4. General Discussion**

The present findings serve as strong support for the supposition that the respective bumps in word-cued and important memories are largely produced by general schematic processes operative at retrieval. Previous studies have shown that the distribution of important and some emotional memories can be simulated (e.g., Rubin & Berntsen, 2003).

The present work is the first demonstration of such an effect for word-cued memories, and for the differential distributions of word-cued and important memories.

As we noted earlier, the bump we attained for the actual word-cued memories skewed slightly earlier than is typically the case (Koppel & Berntsen, 2015), and, in doing so, diverged somewhat from the bump we found for the imagined memories. Therefore, the degree of overlap we attained between the imagined and actual word-cued memories should be taken as an approximation of the degree of overlap one would find with the distributions reported across the literature as a whole – an approximation, moreover, which appears to understate the similarity between the distributions of imagined and actual word-cued memories.

That said, it is worth bearing in mind that the overlap between the imagined and actual memories was considerably stronger in the case of the important memories than the word-cued memories. This makes sense given that the retrieval of important memories is governed in large part by a well-defined cognitive schema, in the form of the life script, whereas, as we address below, the schematic process or processes that contribute towards the retrieval of word-cued memories is less clear. The schematic factors that are operative in the retrieval of word-cued memories may allow more room for memory-based processes to play a role as well.

It might be suggested that the participants in Study 2 were primarily drawing upon their own autobiographical memories in generating the imagined memories of the hypothetical 70-year-old, which, in turn, might explain why the distributions paralleled the distributions of actual memories collected in Study 1. However, this explanation is unlikely for the following reasons.

First, the participants in Study 2 were young adults whose task was to imagine the life of a 70-year-old and generate memories pertaining to this hypothetical person's life. Given

the participants' ages, large portions of the 70-year-old's life were well beyond the periods of the lifespan from which they could have had personal memories. Notably, in light of this consideration, the increase we attained in the number of word-cued memories over the last 15 years of the hypothetical individual's life clearly speaks against a memory-based interpretation of the imagined memory data. This is particularly true when taking the content of the imagined memories from this period into account, as these memories often referred to events concerning such matters as retirement and grandchildren (see Appendix B).

Second, although the location of the bump in the imagined word-cued memories may be consistent with the possibility that participants in Study 2 simply drew upon their own autobiographical memories in generating the imagined memories, the later bump in the imagined important memories is inconsistent with this interpretation, given that this bump extended beyond the age of most of the participants. Here as well, the content of the imagined important memories further goes against this possibility, as they largely represented prominent life script events (e.g., marriage and having children), many of which most of the participants had likely not yet achieved.

Third, theoretical considerations also suggest that one should not expect individuals to rely largely on their own episodic memories in generating imagined memories. It seems justified here to draw a rough parallel between the imagined memory task that we employed in Study 2 and the construction of future events, insofar as they both involve generating imagined events. The construction of future events appears to draw on two cognitive processes, namely, the combining and repurposing of specific details of past events on the one hand, and the application of more general schematic knowledge on the other (for discussion, see Rubin, 2014). Several findings indicate, though, that schematic knowledge plays a larger role in constructing future events than in recalling past events (e.g., Berntsen & Bohn, 2010; Berntsen & Jacobsen, 2008; D'Argambeau & Van der Linden, 2004, 2006;

Newby-Clark & Ross, 2003; Rasmussen & Berntsen, 2013). Therefore, though there is considerable overlap in the psychological and neural processes involved in constructing future events and recalling past events (Schacter & Rose Addis, 2007), an important distinction between the two concerns this greater role of schematic knowledge in constructing future events. We presume that this enhanced role of schematic knowledge is even more characteristic of the imagined memory task employed here, as the construction of autobiographical memories in the life of a hypothetical individual seems a more abstract task than imagining future events in one's own life.

It might alternatively be suggested that participants in Study 2 thought of the personal life of an older individual whom they knew well, such as a grandparent, such that the imagined memories represented actual events from this older individual's life. However, a number of facts speak against this possibility as well. Particularly relevant here is research suggesting that knowledge of specific events from a grandparent's life is typically limited. For example, Stone, van der Haegen, Luminet, and Hirst (2014) found that Belgian individuals who lived through World War II often described their own personal experiences when interviewed about the war, but that their grandchildren rarely referred to their grandparents' personal experiences. Similarly, Berntsen and Thomsen (2005) showed little knowledge of specific events from World War II during the German occupation among younger Danes who had not lived through the war themselves. Therefore, it is unlikely that the imagined events in Study 2 reflected an older person's memories that had been transmitted across generations.

#### **4.1. Accounting for the Bump in Word-Cued and Important Memories**

Analyses of the content of the imagined memories lent support to our hypothesis that the life script schema, in particular, is largely responsible for the bump in important memories, but not word-cued memories. That is, consistent with both the theoretical

formulation of the life script account (Berntsen & Rubin, 2004) and prior empirical findings (Berntsen & Bohn, 2010; Koppel & Berntsen, 2016), life script events primarily drove the bump that we attained for important memories, but played little role in producing the bump in word-cued memories.

Thus, our results are of particular interest in the case of the imagined word-cued memories, as none of the existing accounts of the bump can explain **the overlap between the imagined and actual memories in this domain.** First, our analyses demonstrated that the life script did not underlie the bump we attained for imagined word-cued memories. Second, the stress that the remaining accounts place on processes at encoding and retention renders them likewise poorly suited to explain the present results. A productive avenue for future research would therefore be to investigate alternative explanations of the bump in word-cued memories. In light of the present findings, we would argue that alternative theories of the bump should focus on retrieval processes, rather than stressing the characteristics of the memories themselves (as in the identity formation and cognitive accounts), or the individual's encoding efficiency during the bump period (as in the cognitive abilities account).

To propose one possible retrieval-based explanation of the bump in word-cued memories, an important consideration is that the bump in word-cued memories appears to actually represent a disproportionate number of autobiographical memories in the period immediately after the offset of childhood amnesia (Koppel & Rubin, 2016), rather than reflecting the more traditional conception of the bump as spanning through adolescence and early adulthood. This consideration opens the possibility that the bump in word-cued memories, and possibly the retention component to some degree as well, arises because the retrieval process instigated through the cue word method begins at the most distinctive areas of the search space, namely, the earliest and most recent areas.

This account draws from similar explanations that have been proposed for the serial position curve, which likewise account for the serial position curve as a function of the distinctiveness of temporal or positional cues at the time of recall. Crucially, such accounts have been put forth not only for the serial position curve as attained in episodic memory tasks (Brown, Neath, & Chater, 2007; Shiffrin, 1970; see also Bjork & Whitten, 1974; Murdock, 1960), – the processes for which could not be presumed to overlap with the processes underlying our results for the imagined memory task in Study 2 – but also for recent findings of serial position curves in semantic memory, such as in free recall and ordinal position recall of US presidents, the order of song lyrics, and the ordering of actors by age (Kelley, Neath, & Surprenant, 2013, 2015; Overstreet & Heath, 2011; Overstreet, Heath, & Nealy, 2015; Roediger & DeSoto, 2014; see also Crowder, 1993; Roediger & Crowder, 1976). These findings suggest that human memory is generally structured around distinctive temporal or positional cues, which is therefore potentially the case in autobiographical memory as well.

To be sure, this account is speculative and requires direct testing. That said, unlike current theoretical accounts of the bump, it can apply to both the distribution of actual word-cued memories and the distribution of imagined word-cued memories we attained in Study 2. However, for now our main point is that the present findings call into question the applicability of existing accounts of the bump to the bump in word-cued memories. We will leave it to future researchers to test alternative accounts.

## **4.2. Conclusions**

Through the imaginary construction task employed in Study 2, we have demonstrated that factors relating exclusively to schema-based processes are sufficient to produce, in imagined memories, temporal distributions resembling the distributions found in autobiographical memory proper. In other words, factors relating to qualities and mechanisms of autobiographical memories themselves are not necessary to produce these

distributions. This fact does not necessarily mean that encoding- and retention-related processes play no role in producing the lifespan distribution of autobiographical memories, including, most notably, the bump; particularly in the case of word-cued memories, our attainment of greater divergence between the distributions of the imagined and actual memories in this domain suggests that memory-based processes underlie the distribution of word-cued memories to a greater extent than they underlie the distribution of important memories.

However, given the similarity between the distributions we attained for imagined and actual memories, parsimony demands that we initially consider accounts positing that similar mechanisms underlie both distributions as substantially underlying the lifespan distribution of autobiographical memories, before turning to accounts suggesting that these two similar distributions are produced by differential processes. The reminiscence bump has long been regarded as a hallmark of the unique processes of autobiographical memory. In contrast to this view, we have shown here that it can be produced by cognitive mechanisms that are unrelated to autobiographical remembering *per se*.

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*Appendix A*

## Cue Words Used

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Ambulance	Hospital
Baby	Ink
Beggar	Jelly
Book	Lake
Bowl	Money
Boy	Mountain
Butter	Ocean
Butterfly	Paper
Candy	Pencil
Chair	Plant
Child	Prairie
City	River
Clothing	Salad
Corpse	Ship
Doctor	Star
Door	Street
Dress	Table
Flower	Tobacco
Fur	Water
Hammer	Window
Horse	Wine

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*Appendix B*

## Sample Imagined Memories From Study 2

## Word-Cued Memories

Example 1: In school, the first time she learned about the Holocaust or saw pictures of the concentration camps. (In association to *corpse*; age 10)

Example 2: A trip to Vietnam, where a bamboo bowl was bought to bring home. (In association to *bowl*; age 18)

Example 3: A spring day where the family is together, that is, the man's wife and children are out sailing on a Danish ship. A sense of joy at being with his family. (In association to *ship*; age 45)

Example 4: When she bought a mink fur coat in connection with her retirement as a reward for all her hard work. (In association to *fur*; age 65)

Example 5: When, as a 70-year-old, she taught her granddaughter how to make jam. (In association to *jelly*; age 70)

## Most Important Memories

Example 1: Being kissed for the very first time at a ball. (Age 15)

Example 2: Her wedding. It takes place in a church and a lot of money is spent on the party. (Age 26)

Example 3: The birth of his first child. He would remember the day at the hospital and his son/daughter coming into the world as the most important event. (Age 28)

Example 4: One of her parents' deaths. She is in her mid-fifties and feels helpless and crushed for the first time in a long time. (Age 55)

Example 5: Celebrating her golden wedding anniversary with her husband and the whole family. (Age 70)

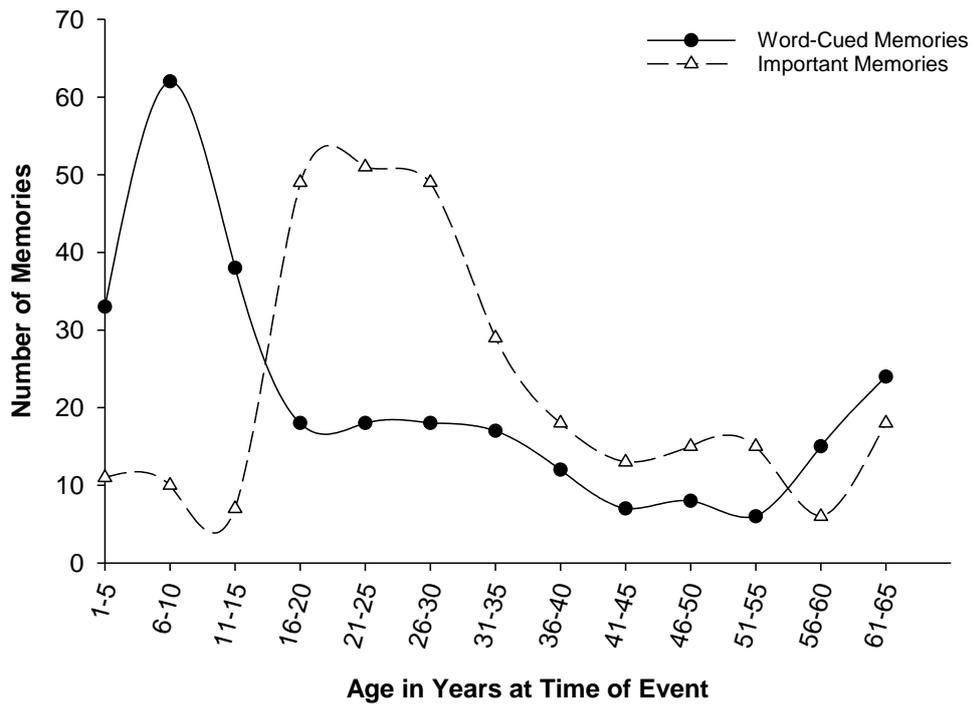


Figure 1. Temporal distributions, from Study 1, of actual word-cued and most important autobiographical memories.

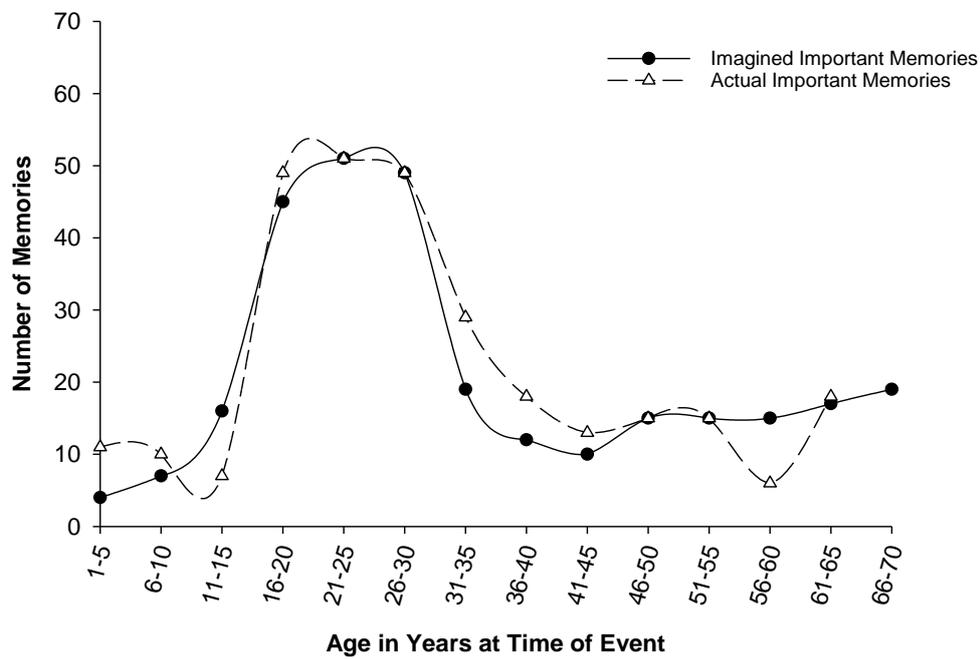
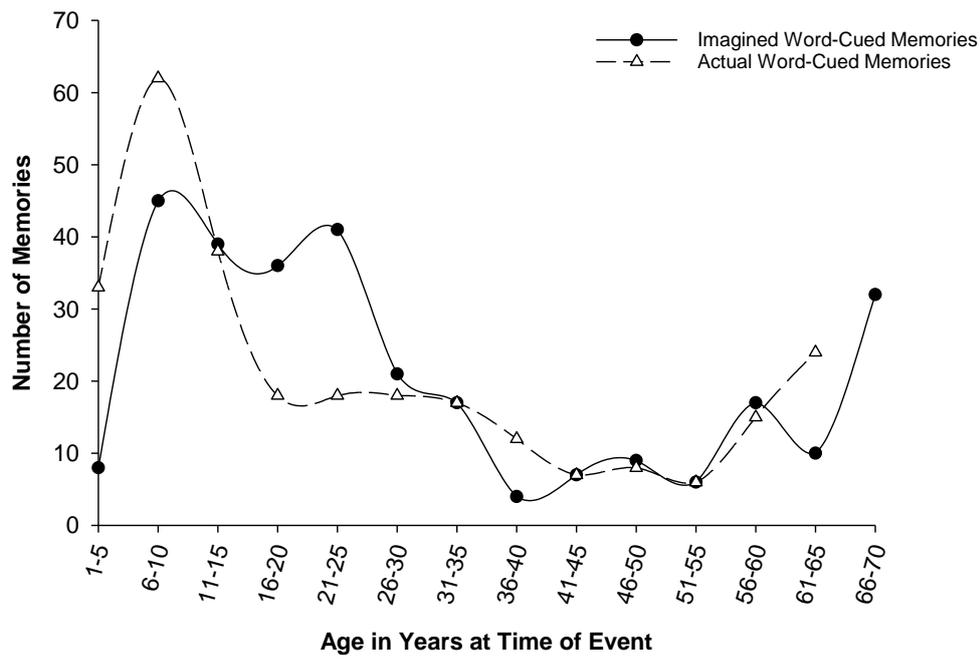


Figure 2. Temporal distributions of imagined (from Study 2) and actual (from Study 1) word-cued and most important autobiographical memories. The top panel contains the distributions of each type of word-cued memory, and the bottom panel contains the distributions of each type of most important memory.