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The Dynamics of Memory for United States Presidents in Younger and Older Adults

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Abstract

Serial position effects are often observed within the free recall of unassociated words but also when recalling items from a semantic category like U.S. presidents. We investigated the dynamics of recall for U.S. presidents in younger and older adults to examine potential age-related differences in the organization of retrieval from semantic long-term memory. Older adults recalled more presidents than younger adults and also demonstrated dual serial position effects such that, in addition to overall serial position effects, primacy (e.g., Eisenhower) and recency presidents (e.g., Obama) within older adults' lifetime were better recalled than presidents from the middle of their lives (e.g., Ford). Additionally, participants initiated recall with the most distinct presidents (highly familiar or memorable presidents like Washington, Obama, Trump), and conditional-response probabilities revealed that presidents from similar eras were recalled in close proximity, indicating that the retrieval of distinct presidents can facilitate memory for presidents from a similar era. Collectively, we demonstrate the potential interplay of the mechanisms that influence the organization of retrieval such that distinctiveness and temporal contiguity effects may simultaneously impact recall. Specifically, semantic and temporal-contextual associations can drive semantic autobiographical memory and people likely organize retrieval from long-term memory according to familiarity and distinctiveness.

Keywords

serial position effects; aging; semantic memory; distinctiveness; lag-recency effects

In long-term memory, two sources of declarative memory have been proposed and identified: e*pisodic* and *semantic memory* (Tulving, 1972). Episodic memory involves conscious autobiographical memories of past experiences, such as going to a football game last week, and depends on information about the temporal context (i.e., episodes) of the learning situation. In contrast, semantic memory involves generalized knowledge of the world (e.g., facts and concepts) which has been acquired over time and does not depend

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Conflicts of Interest
The authors certify that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

The experiment reported in this article were not formally preregistered but the stimuli and data have been made available on the Open Science Framework here.

on information about the temporal context of the learning situation (Tulving, 2002). While these memory systems may represent unique sources of long-term memory, there is debate regarding how these systems interact (e.g., Levine et al., 2002; Winocur & Moscovitch, 2011) and how this interaction changes later in life.

When recalling information from semantic and episodic memory, the relative distinctiveness principle posits that information is well remembered to the extent that said information is more distinct than competing information during retrieval (Surprenant & Neath, 2009). For example, when remembering the United States (U.S.) presidents, presidents like George Washington, John Adams, and John F. Kennedy are often well remembered compared to many of their less distinct peers like John Tyler or Warren Harding (e.g., Neath, 2010). Distinctiveness can encompass increased memorability, greater familiarity, and in the context of remembering the U.S. presidents, the magnitude of their accomplishments while in office. As such, history classes, a recent close election, or a previous memorable president may have lasting effects on how well U.S. presidents are remembered. For example, high school students in the U.S. typically take an American history class and are frequently exposed to the names of former presidents like George Washington and John Adams. As a result, most people know that Washington and Adams were the first two presidents and are highly familiar with these presidents. Furthermore, many people have flashbulb memories (i.e., a highly detailed and vivid memory of a particular event) involving U.S. presidents such as the assassination of John F. Kennedy (Cohen et al., 1994; Tekcan & Peynircioğlu, 2002; Winograd & Killinger, 1983), making the 35th president relatively distinct in long-term memory compared to other presidents in his era.

When recalling the presidents, memory may vary among groups of people based on the decade of birth (i.e., cohort effects) such that older adults have been around for more presidencies, potentially leading to greater familiarity and distinctiveness in their memory for the presidents. However, people generally experience cognitive decline with increased age (cf., Hess, 2005; Park & Festini, 2017; Salthouse, 2010) possibly leading to poorer memory for the presidents compared with younger adults. Despite some memory decline in older adults, age-related memory deficits are known to be reduced under conditions of increased distinctiveness (see Smith, 2006, 2011) and when retrieval can be supported by semantic memory rather than episodic memory (Bäckman et al., 2001; Foos & Sarno, 1998; Riby et al., 2004; see also Craik, 2000). Thus, since remembering the presidents involves both semantic and episodic memory, older adults may outperform younger adults in recalling the presidents due to the benefit of having more episodic memories to draw from and when retrieval from semantic memory is driven by familiarity and distinctiveness.

When recalling information from long-term memory, the probability that an item is recalled is often predicted by its temporal order at encoding. Specifically, individuals often exhibit a primacy effect, the tendency to recall items presented first most accurately, as well as a recency effect, the tendency to recall items presented last most accurately, both relative to poorer recall of items in the middle of a list (Murdock, 1962). Previous work indicates that serial position effects in episodic memory tasks are largely driven by increased rehearsal for primacy items (Fischler et al., 1970; Rundus, 1971; Rundus & Atkinson, 1970; see also Murphy et al., 2021) whereas recency effects are generally attributed to retrieval from working memory (see Davelaar et al., 2005).

While most studies examining serial position effects require participants to remember lists of unassociated words (i.e., an episodic memory task), researchers sometimes ask participants to recall items from a category with a natural serial order such as U.S. presidents (i.e., primarily a semantic memory task). First reported by Roediger and Crowder (1976), this category of free recall also typically results in primacy and recency effects (Crowder, 1993; DeSoto & Roediger, 2019; Healy et al., 2000; Healy & Parker, 2001; Neath, 2010; Roediger & DeSoto, 2014; see also Neath & Saint-Aubin, 2011, for an example with Canadian prime ministers). Similar to episodic memory tasks, serial position effects in recall from semantic memory can be driven by increased rehearsal (i.e., we often hear about early and recent presidents like Washington or Obama) and are also attributable to the relative distinctiveness principle (i.e., Lincoln is highly memorable due to his accomplishments and references in history, depiction on the penny, etc.). Thus, some presidents may be more memorable as a result of both increased distinctiveness and rehearsal (which highly overlap; see Healy et al., 2000 for a discussion of the circularity between rehearsal and distinctiveness), whereby distinctiveness leads to more exposure and additional encoding.

In addition to serial position effects, episodic free recall tasks have shown that items presented close together on a list tend to be recalled in close proximity (Howard & Kahana, 1999; Kahana, 1996; Spillers & Unsworth, 2011). This pattern is captured by conditional-response probabilities as a function of lag (lag-CRPs) which provide a quantitative assessment of how individuals transition between responses during recall. These probabilities provide evidence that when an item is recalled, people rely on accompanying temporal-contextual relationships (i.e., the shared context of words presented closer together in time that can benefit retrieval) to retrieve additional items. Because items presented near each other share more temporal-contextual features than those that are farther apart, recalled items contain information that can be used as a cue to continue the search for additional items, increasing the probability of recalling nearby items, known as the *lag-recency effect*.

Since participants often rely on temporal-contextual relations to recall high proximity items in episodic free recall tasks, participants may demonstrate a similar pattern when recalling U.S. presidents. However, lag-recency effects often vary according to the degree of semantic associations among to-be-remembered items and are usually more pronounced when the items are unrelated (Healey & Uitvlugt, 2019; Kahana, 2017; Long & Kahana, 2017; Polyn et al., 2009, 2011). Thus, when semantic information is less available, participants rely more heavily on temporal context for organizing retrieval but the lag-recency effect may still benefit memory for the presidents.

Although recalling the U.S. presidents largely taps semantic memory, recall of the presidents may be organized based on temporal context. Specifically, similar to how lag-recency effects in a list of to-be-remembered words depend on having experienced each word close together in time, when remembering the presidents, retrieving a given president may activate the mental context associated with that president which can then facilitate the retrieval of more presidents from that or a similar context (but this context may be temporal, semantic, or a combination of the two). Thus, rather than retrieving presidents from memory in an unorganized fashion, participants may recall presidents from similar eras together due to their chronological presidential terms, semantic associations, and shared temporal-contextual relations. This would provide evidence that the distinctiveness of a memorable president can act as a retrieval cue for presidents from a similar era.

Some have argued that semantic and episodic memory function on a continuum (Craik, 2002; Lachman, & Naus, 1984) or may be distinct (Anderson & Ross, 1980), but both episodic and semantic memory retrieval likely stem from the same type of processing such that presidents that are more distinct from their predecessors and successors at the time of recall will be better remembered. Moreover, the recall of a distinct president may facilitate retrieval for presidents from a similar era. For example, if two events, A and B, are experienced in close temporal proximity, information about A facilitates the retrieval of B and vice versa. Applied to the U.S. presidents, presidents serving in close temporal proximity likely also share semantic similarity (e.g., Bush and Obama served adjacent terms but also share many semantic connections like the challenges of the Great Recession) and prior work on autobiographical and semantic memory suggests that such semantic connections can artificially increase the perceived temporal contiguity (e.g., Moreton & Ward, 2010; Uitvlugt & Healey, 2019). Thus, the temporal-contextual relations between presidents of similar eras in long-term memory may result in presidents from similar periods being recalled in close proximity.

The Current Study

Examining the retrieval dynamics of free recall for the U.S. presidents provides a unique opportunity to investigate the role of distinctiveness in recall, potentially further elucidating participants' organization of retrieval from long-term memory. Specifically, we hope to characterize age-related differences in the organization of semantic memory (with possible contributions from episodic memory). Based on prior work (e.g., Crowder, 1993; Neath, 2010; Roediger & DeSoto, 2014) and unpublished pilot data we collected before the Obama and Trump era (32 younger and 32 older adults), we expected participants to demonstrate primacy and recency effects, regardless of age, indicating that the early and recent presidents are best encoded relative to middle presidents.

Since evidence suggests that semantic memory is preserved in older adults (Bäckman et al., 2001; Foos & Sarno, 1998; Riby et al., 2004), we expected younger and older adults to demonstrate similar recall of primacy presidents. However, we expected age-related differences when retrieving recency items such that older adults may show dual serial position effects by also demonstrating a primacy and recency effect within their recency items (in addition to overall serial position effects). Specifically, older adults may successfully recall presidents from their youth, consistent with a reminiscence bump, the over-representation of memories from one's youth (see Koppel, 2013; Koppel & Rubin, 2016; Steiner et al., 2014). As such, the reminiscence bump may contribute to the additional primacy effect in older adults via autobiographical memory as they might be prone to remember the first president they first voted for or where they were when John F. Kennedy was assassinated. Older adults may then moderately recall presidents from the middle of their life and successfully recall most modern presidents (a recency effect). Conversely, while older adults have been alive for many presidencies, allowing for greater familiarity or distinctiveness driven by semantic autobiographical knowledge (e.g., older adults may remember voting for Jimmy Carter), only a handful of presidents have served during the lifetimes of younger adults. Therefore, we did not expect younger adults to show serial position effects within their recall of recent presidents.

In addition to serial position effects, we also investigated retrieval patterns to determine how participants initiate retrieval and transition between presidents. When beginning recall in episodic memory tasks, both younger and older adults typically first recall either the first or last presented item in a list (i.e., probability of first recall, PFR; Howard & Kahana, 1999; Kahana et al., 2002). Specifically, participants are more likely to initiate recall with the last presented item in immediate free recall tasks but if a delay precedes recall, PFR for recency items is greatly reduced and participants are more likely to initiate recall with primacy items, adding to primacy and recency effects and emphasizing the contributions of short- and long-term memory. Similar to episodic memory tasks, when recalling the U.S. presidents, we expected both younger and older adults to initiate retrieval from semantic memory with primacy or recency presidents (e.g., Washington or Trump/Obama) as these may be the most distinct in semantic memory.

After participants begin recall, more systematic tendencies are often observed in participants' retrieval such as *lag-recency effects*: the tendency for items presented in close temporal proximity to be recalled in close proximity. Similar to memory for unassociated word lists, we expected temporal-contextual associations to drive recall from semantic memory. However, previous work has revealed age-related deficits in the lag-recency effect, particularly for small lags in the forward direction (Healey & Kahana, 2016; Kahana et al., 2002; Wahlheim & Huff, 2015). Thus, although we expected participants to generally rely on temporal-contextual relations to recall high proximity presidents, resulting in presidents being recalled in systematic blocks based on their era, we expected lag-recency effects to be reduced in older adults.

Method

Participants.—After exclusions, participants were 56 younger adults (age range: 20–29, $M = 24.79$, $SD = 1.85$) and 56 older adults (age range: 56–76[1], $M = 62.68$, $SD = 5.17$) recruited from Amazon's Mechanical Turk, a Web site that allows users to complete small tasks for pay (see Buhrmester et al., 2011 for discussion of validity). The sample size was selected based on prior exploratory research and the expectation of detecting a medium effect size. A sensitivity analysis indicated that for a two-group test of independent means, assuming alpha = .05, power = .80, for a two-tailed test, the smallest effect size the design could reliably detect was $d = .53$.

[1]While other research has used higher age cutoffs for older adults, we used a lower cutoff that allows for more of a middle age/lifespan approach. Although we acknowledge that this lower minimum age differs from studies that use an older cutoff, in the context of studying cognitive aging, learning more about younger-older adults is also informative.

Participants received $1.50 for completing the experiment, which took approximately 10 minutes, and were required to have completed a high school degree in the United States to participate. Younger adults were restricted to ages 18–30 and older adults were restricted to ages 55–85. Participants were excluded from analysis if they admitted to cheating (e.g., looking up answers) in a post-task questionnaire (they were told they would still receive credit if they cheated). This exclusion process resulted in 14 exclusions from the younger adult group and two exclusions from the older adult group. The experiment was conducted in March of 2020.

Procedure.—Participants were instructed to retrieve as many items from the category "United States Presidents" as possible in 5 minutes, which prior research has indicated is sufficient time to exhaust participants' knowledge (Roediger et al., 1982). Participants were informed that they could retrieve items in any order that they wished (participants typed their responses in a single text box) but that they should keep trying to retrieve items throughout the entire 5 minute period. After the free recall period, participants completed a brief questionnaire regarding any search strategies they had used during the task.

Scoring.—If participants recalled a president with a shared last name (e.g., John Adams and John Quincy Adams) but did not provide enough information to discern which president they had recalled, the president was counted as correct towards participants' overall performance but was not counted as correct for serial position analyses. Additionally, participants' incorrect responses due to spelling errors or typos were counted if the intent of the response was clear (e.g., the response "Obma" was interpreted as "Obama").

Results

Age-related differences.—Free recall for the U.S. presidents as a function of their term in office is shown in Figure 1. To investigate differences in recall of the presidents, an independent samples *t*-test revealed that older adults recalled more presidents ($M = 19.66$, $SD = 6.88$) than younger adults ($M = 14.07$, $SD = 8.09$), [$t(110) = 3.94$, $p < .001$, $d = .74$] similar to our in-lab pilot study. Although many studies have demonstrated episodic memory deficits in older adults (see Old & Naveh-Benjamin, 2008 for a review), in the current study, older adults recalled more presidents than younger adults suggesting that certain forms of memory (i.e., semantic or semantic autobiographical memory) are maintained in older age (cf., Hess, 2005; Park & Festini, 2017; Salthouse, 2010).

To determine whether older adults recalled more presidents due to enhanced recall of presidents from a certain era, we investigated age-related differences in recall of primacy items (first 7 presidents), middle presidents (8^{th}-33^{rd} presidents), and recency presidents (last 12 presidents). Era criterion was based on the trends observed in Figure 1 and similar trends observed in Roediger and DeSoto (2014). Specifically, the seventh president was moderately well recalled but there was a large drop in recall performance starting with the eighth president; the last 12 presidents were considered recency presidents since the average older adult in our sample was born in 1957 which was during Eisenhower's presidency.

To examine age-related differences in recall from each era, we first conducted a 2 (age: young, old) × 7 (first 7 presidents) ANOVA. Results revealed a main effect of presidency

[Mauchly's $W = .37$, $p < .001$, Huynh-Feldt corrected results: $F(5.16, 567.91) = 51.29$, $p < .001$, $\eta 2 = .31$] such that recall for the presidents generally declined with each successive presidency. However, there was not a main effect of age [$F(1, 110) = 3.47$, $p = .065$, $\eta 2 = .03$] and age did not interact with presidency [$F(5.16, 567.91) = 1.80$, $p = .108$, $\eta 2 = .01$]. Next, a 2 (age: young, old) × 25 (8^{th}-33^{rd} presidents) ANOVA revealed a main effect of presidency [Mauchly's $W < .01$, $p < .001$, Huynh-Feldt corrected results: $F(17.51, 1925.75) = 33.54$, $p < .001$, $\eta 2 = .23$] such that recall for the presidents generally declined with each successive presidency. Additionally, there was a main effect of age [$F(1, 110) = 9.93$, $p = .002$, $\eta 2 = .08$] and age interacted with presidency [$F(17.51, 1925.75) = 2.55$, $p < .001$, $\eta 2 = .02$] such that older adults recalled more presidents than younger adults, particularly due to enhanced memory for Roosevelt and his successors. To examine recall of recent presidents, a 2 (age: young, old) × 12 (last 12 presidents) ANOVA revealed a main effect of presidency [$F(11, 1210) = 22.74$, $p < .001$, $\eta 2 = .16$] such that recall for the presidents generally improved with each successive presidency. Additionally, there was a main effect of age [$F(1, 110) = 14.45$, $p < .001$, $\eta 2 = .12$] and age interacted with presidency [$F(11, 1210) = 7.41$, $p < .001$, $\eta 2 = .05$] such that older adults recalled more presidents than younger adults, particularly due to memory for presidents serving prior to younger adults' lifetimes.

Together, the present results potentially reflect a cohort effect as a result of differences in the quality of history education across age groups. Alternatively, these differences may reflect greater familiarity and distinctiveness of each president driven by semantic autobiographical knowledge in older adults. Specifically, similar levels of knowledge for historic presidents may explain the comparable recall of primacy items in each of the age groups; however, fewer presidencies have occurred during the lifetimes of younger adults resulting in greater familiarity and relative distinctiveness in memory for older adults, potentially leading to their better overall performance.

Serial position effects.—To investigate age-related differences in the dynamics of participants' recall, we examined recall as a function of presidential serial position. A repeated-measures ANOVA with serial position (44 levels)[2] as a within-subjects factor and age (young, old) as a between-subjects factor revealed a main effect of serial position [$F(43, 4730) = 57.60$, $p < .001$, $\eta 2 = .34$], a main effect of age [$F(1, 110) = 13.77$, $p < .001$, $\eta 2 = .11$], and an interaction between serial position and age [$F(43, 4730) = 3.68$, $p < .001$, $\eta 2 = .02$]. To supplement these findings and further examine recall as a function of serial position and age, we computed quadratic regressions which are shown in Table 1. These models revealed significant quadratic trends such that there were serial position effects in both younger and older adults' recall. Specifically, term in office (i.e., serial position) significantly predicted recall of the presidents with early and recent presidents being better recalled than presidents from the middle of history. Collectively, these results suggest that there were serial position effects, older adults recalled more presidents than younger adults, and this trend varied as a function of serial position.

[2]Although there have been 45 presidencies, there have only been 44 presidents (Grover Cleveland was the 22^{nd} and 24^{th} president) and we only counted the recall of Grover Cleveland as correct for position 22 (we did not include serial position 24 in any analyses).

In addition to better overall performance, older adults demonstrated apparent dual serial position effects in their recall. To investigate primacy and recency effects in younger and older adults' recall of presidents who held office during older adults' lifetimes, we conducted a repeated-measures ANOVA with serial position (12 levels) as a within-subjects factor and age as a between-subjects factor. This analysis revealed a serial position by age interaction [$F(11, 1210) = 7.41$, $p < .001$, $\eta 2 = .05$] reflecting age-related differences in recall of recent presidents. To probe this interaction, we examined the simple effects in a post-hoc 2 (age: young, old) × 3 (primacy, middle, recency items) ANOVA. In the older adults, results revealed a significant difference between presidents from early in their lives (presidents 34 through 37; $M = .77$, $SD = .25$) and presidents from the middle of their lives (presidents 38 through 41; $M = .65$, $SD = .35$), [$p_{\text{holm}} = .021$] but not between presidents from early in older adults' lives and recent presidents (presidents 42 through 45; $M = .78$, $SD = .23$), [$p_{\text{holm}} > .999$]; additionally, results revealed a significant difference between presidents from the middle of older adults' lives and recent presidents [$p_{\text{holm}} = .014$]. In the younger adults, results did not reveal a significant difference between presidents 34 through 37 ($M = .42$, $SD = .33$) and presidents 38 through 41 ($M = .49$, $SD = .32$), [$p_{\text{holm}} = .361$][3]; however, there was a significant difference between presidents 34 through 37 and recent presidents (presidents 42 through 45; $M = .79$, $SD = .23$), [$p_{\text{holm}} < .001$] and between presidents 38 through 41 and recent presidents [$p_{\text{holm}} < .001$]. Collectively, these results illustrate the dual serial position effects in older adults' recall of recent presidents while younger adults only demonstrated elevated recall of modern presidents.

Organization of recall.—To investigate age-related differences in how participants initiated retrieval, we examined the probability of first recall (PFR) as a function of presidential serial position (see Figure 2). A repeated-measures ANOVA with serial position (44 levels) as a within-subjects factor and age as a between-subjects factor revealed a main effect of serial position [$F(43, 4730) = 38.02$, $p < .001$, $\eta 2 = .25$] such that participants tended to begin recall with the first or last two presidents. However, serial position interacted with age [$F(43, 4730) = 2.60$, $p < .001$, $\eta 2 = .02$] suggesting that participants tended to initiate recall with the first or last two presidents but older adults were more likely to initiate retrieval with George Washington (the first president) than younger adults [$p_{\text{holm}} < .001$] while younger adults were more likely to initiate retrieval with Barack Obama compared with older adults [$p_{\text{holm}} < .001$].

To determine if the recall of presidents is driven by temporal-contextual cues, we calculated conditional-response probabilities as a function of lag, a dynamic of long-term memory retrieval that can affect performance via accompanying temporal-contextual information. Lag is the ordinal space between serial positions (e.g., the lag between Nixon and Ford would be 1). Accordingly, the conditional-response probability illustrates the probability that an item from serial position $i +$ lag is recalled immediately following an item from serial position i. The direction of recall is indicated by the sign of the lag, with positive values indicating the forward direction and negative values indicating the backward direction (Kahana, 1996). The CRP for each recall transition was computed by summing the number

[3]Although younger adults also appear to demonstrate a primacy effect within recency presidents (as seen in Figure 1), this was driven by the excellent recall of John F. Kennedy, not elevated recall of multiple presidents from that era.

of times the transition of each lag occurred divided by the number of times that transition could have occurred. Plotting the probability of recalling a president from serial position x followed by a president from serial position y for different lags is shown in Figure 3.

A 5 (lag: 1–5) × 2 (direction: forward vs backward) repeated-measures ANOVA with age as a between-subjects factor revealed that participants did not show a preference for transitioning between presidents in the forward or the backward direction [$F(1, 110) = 3.58$, $p = .061$, $\eta2 = .03$] and this did not differ between age groups [$F(1, 110) = .42$, $p = .520$, $\eta2 < .01$]. However, an analysis of adjacency effects revealed strong effects of lag [Mauchly's $W = .15$, $p < .001$, Huynh-Feldt corrected results: $F(2.13, 234.47) = 55.67$, $p < .001$, $\eta2 = .33$] but lag did not interact with age [$F(2.13, 234.47) = 1.47$, $p = .232$, $\eta2 = .01$], indicating that both younger and older adults recalled presidents from similar eras together. Additionally, there was not an interaction between direction and lag [Mauchly's $W = .23$, $p < .001$, Huynh-Feldt corrected results: $F(2.34, 256.92) = 1.07$, $p = .352$, $\eta2 = .01$] and there was not a three way interaction between direction, lag, and age [$F(2.34, 256.92) = .49$, $p = .645$, $\eta2 < .01$]. Finally, there was not a main effect of age [$F(1, 110) = .01$, $p = .909$, $\eta2 < .01$] indicating that younger and older adults demonstrated similar lag-recency effects.

To supplement these findings and further examine age-related differences in the lag-recency effect, we fit an exponential function for each participant with lags +1 to +5 as the inputs. We then fit another exponential function for each participant with lags −1 to −5 as the inputs. Next, we computed the average of the resulting exponential fits to provide a reasonable summary of the tendency to recall items in close temporal proximity; the more negative the exponential fit score, the greater the lag-recency effect. There was a significant difference in the lag-recency effect between younger ($M = -4.01$, $SD = 2.27$) and older adults ($M = -2.62$, $SD = 2.50$), [$t(110) = 3.08$, $p = .003$, $d = .58$] such that younger adults demonstrated stronger lag-recency effects than older adults.

Lifetime effects.—To compare memory for presidents that did and did not serve during younger and older adults' lives, we first calculated the proportion of presidents recalled that served during participants' lifetimes. We determined which presidents served during participants' lifetimes based on the average birth year of younger adults (1996) and older adults (1957). Specifically, the average older adult in our sample was born in 1957, indicating that the first president that served during their lifetimes was Dwight D. Eisenhower. Conversely, the average younger adult in our sample was born in 1996, indicating that the first president that served during their lifetimes was Bill Clinton. An independent samples t-test revealed that older adults recalled a similar proportion of presidents ($M = .73$, $SD = .22$) from their lifetime as younger adults ($M = .79$, $SD = .23$), [$t(110) = 1.38$, $p = .171$, $d = .26$]. Similarly, older adults recalled a similar proportion of presidents ($M = .31$, $SD = .19$) from before their lifetime as younger adults ($M = .25$, $SD = .19$), [$t(110) = 1.54$, $p = .127$, $d = .29$].

To examine the lag-recency effect for only presidents serving during participants' lifetimes, we examined CRPs based only on the recall of these presidents (see Figure 4a). Specifically, we only considered transitions where both the just-recalled president and the president involved in the transition served during the participants' lifetime. A 5 (lag: 1–5) × 2 (direction: forward vs backward) repeated-measures ANOVA with age as a between-subjects factor revealed that participants did not show a preference for transitioning between presidents in the forward or the backward direction [$F(1, 110) = .46$, $p = .497$, $\eta 2 < .01$] and this did not differ between age groups [$F(1, 110) = .87$, $p = .353$, $\eta 2 = .01$]. However, an analysis of adjacency effects revealed strong effects of lag [Mauchly's $W = .31$, $p < .001$, Huynh-Feldt corrected results: $F(2.73, 300.74) = 66.39$, $p < .001$, $\eta 2 = .36$] but lag interacted with age [$F(2.73, 300.74) = 10.44$, $p < .001$, $\eta 2 = .06$] such that younger adults showed a stronger effect of 1 lag. Additionally, there was not an interaction between direction and lag [Mauchly's $W = .20$, $p < .001$, Huynh-Feldt corrected results: $F(2.24, 246.26) = .94$, $p = .401$, $\eta 2 = .01$] and there was not a three way interaction between direction, lag, and age [$F(2.24, 246.26) = 1.08$, $p = .348$, $\eta 2 = .01$]. Finally, there was a not main effect of age [$F(1, 110) = 2.12$, $p = .148$, $\eta 2 = .02$] indicating that younger adults demonstrated greater lag-recency effects for presidents serving during their lifetimes.

Next, we examined CRPs for the recall of presidents that did not serve during participants' lifetimes (see Figure 4b). A 5 (lag: 1–5) × 2 (direction: forward vs backward) repeated-measures ANOVA with age as a between-subjects factor revealed that participants did not show a preference for transitioning between presidents in the forward or the backward direction [$F(1, 110) = 2.63$, $p = .107$, $\eta 2 = .02$] and this did not differ between age groups [$F(1, 110) = .82$, $p = .369$, $\eta 2 = .01$]. However, an analysis of adjacency effects revealed effects of lag [Mauchly's $W = .66$, $p < .001$, Huynh-Feldt corrected results: $F(3.49, 383.80) = 13.12$, $p < .001$, $\eta 2 = .11$] but lag did not interact with age [$F(3.49, 383.80) = .87$, $p = .470$, $\eta 2 = .01$]. Additionally, there was not an interaction between direction and lag [Mauchly's $W = .51$, $p < .001$, Huynh-Feldt corrected results: $F(3.29, 361.42) = .18$, $p = .925$, $\eta 2 < .01$] and there was not a three way interaction between direction, lag, and age [$F(3.29, 361.42) = .15$, $p = .943$, $\eta 2 < .01$]. Finally, there was not a main effect of age [$F(1, 110) < .01$, $p = .975$, $\eta 2 < .01$][4] indicating that both younger adults demonstrated similar lag-recency effects for presidencies occurring before their lifetimes.

Lastly, we again computed exponential fit scores on the CRPs for presidents serving during participants' lifetimes as well as for presidents not serving during participants' lifetimes. To analyze the strength of the lag-recency effect as a function of both age and whether presidents served during participants' lifetime, we computed a 2 (age: young, old) × 2 (time: served during participants' lifetime, did not serve during participants' lifetime) ANOVA. Results revealed a main effect of time [$F(1, 110) = 18.42$, $p < .001$, $\eta 2 = .14$] such that the lag-recency effect was greater for the recall of presidents serving during participants' lifetimes ($M = -3.12$, $SD = 2.26$) than presidents not serving during participants' lifetimes ($M = -1.63$, $SD = 2.71$). However, results did not reveal a main effect of age [$F(1, 110) = 3.29$, $p = .073$, $\eta 2 = .03$] such that younger adults demonstrated a similar lag-recency effect ($M = -2.66$, $SD = 1.53$) as older adults ($M = -2.09$, $SD = 1.78$). Additionally, age did not interact with time [$F(1, 110) = 2.45$, $p = .120$, $\eta 2 = .02$]. Together, these results indicate that the recall of presidents from participants' lifetimes largely drives the lag-recency effect.

[4]Although the three-way interaction was not significant, perhaps due to only four presidencies occurring during younger adults' lifetimes, younger adults appeared to prefer to move in the backward direction using 1 lag increments (i.e., recalling Trump, then Obama, then Bush, etc.) when recalling presidents who served during their lives.

Discussion

While serial position effects in traditional free recall tasks often reflect different aspects of memory like working and long-term memory (Glanzer & Cunitz, 1966), participants in the present study completed a free recall task with a natural serial order (US presidents), primarily reflecting recall from semantic memory. Serial position effects are often observed within recall from semantic memory (see Kelley et al., 2013, 2014; Maylor, 2002), and the frequency of exposure (i.e., familiarity) as well as item distinctiveness are primarily responsible for serial position effects in semantic memory (but see Healy et al., 2008). Consistent with previous work (Crowder, 1993; DeSoto & Roediger, 2019; Healy et al., 2000; Healy & Parker, 2001; Neath, 2010; Neath & Saint-Aubin, 2011; Roediger & Crowder, 1976; Roediger & DeSoto, 2014), we demonstrated that similar principles (e.g., familiarity and distinctiveness) can govern recall and serial position effects for semantic information (i.e., presidents), similar to more classic episodic serial position effects (i.e., recalling word lists).

In the present study, participants' recall resembled a conventional serial position function whereby early presidents were well recalled (the primacy effect) and the last few presidents were also better remembered (the recency effect) relative to those in the middle. Since many people are required at some point during their education to learn the presidents and their accomplishments, it is not surprising to observe that primacy presidents are frequently successfully retrieved. Similarly, the recall of recency items indicates that participants remember presidents relatively well if they held office during or just before the participants' lifetimes. However, recall performance decreases as one attempts to retrieve presidents whose terms were more distant in time and of less significance, such as William Henry Harrison.

While both younger and older adults' recall resulted in overall serial position effects, older adults showed dual serial position effects such that they demonstrated primacy and recency effects for the presidents who served during their lifetime. Starting with Dwight Eisenhower (34th president), older adults demonstrated elevated recall for presidents who held office during their youth (perhaps due to the reminiscence bump, the over-representation of memories from one's youth; see Koppel, 2013; Koppel & Rubin, 2016; Steiner et al., 2014). Additionally, most modern presidents were also successfully recalled but performance decreased for the presidents from the middle of their lifetime (e.g., Jimmy Carter). However, this additional serial position effect only occurred for presidents serving during their lifetimes; recall of presidents from early American history generally declined with each successive presidency except for Abraham Lincoln and Theodore Roosevelt, who were recalled far more frequently than their unfavorable serial positions would typically produce, supporting familiarity and distinctiveness accounts of serial position effects in semantic memory.

The present results are consistent with explanations of relative distinctiveness (Neath, 2010) such that presidents like Washington, Lincoln, Kennedy, Obama, and Trump show a retrieval advantage as a result of enhanced historical significance and frequency of exposure relative to their competitors (Kelley et al., 2015). Hence, enhanced memory for primacy and recency presidents may reflect greater distinctiveness or familiarity driven by semantic autobiographical knowledge. Specifically, memory for personal events and historical knowledge engages the relative distinctiveness principle and the current study showed a behavioral dissociation between primacy and recency presidents. We provide evidence that older adults can outperform younger adults when they can rely on semantic autobiographical memory, consistent with prior work indicating that people experience a loss of episodic detail but an increase in semantic detail in autobiographical memory with age (see Craik, 2000).

Although we observed dual serial position effects for recency items in older adults, results revealed minimal age-related differences in the recall of primacy presidents, consistent with the view that semantic memory is preserved in older adults (Bäckman et al., 2001; Foos & Sarno, 1998; Riby et al., 2004). However, these studies also demonstrated age-related declines in episodic memory (but see Rendell et al., 2005), indicating that the episodic and semantic memory systems may be differentially affected by age. In the current study, older adults' better performance was due in large part to their elevated recall of middle and recent presidents, potentially resulting from enhanced semantic autobiographical memory. Thus, the effects of aging may be reduced when memories were formed in a naturalistic setting and have greater contextual cues and relevance to one's life (see Hess, 2005).

The observed older adult advantage may also have resulted from cohort effects. For example, older adults may better remember John F. Kennedy because of his assassination whereas younger adults are less familiar with this president/event, perhaps associating John F. Kennedy with an airport. However, in addition to illustrating age-related differences in memory, the present study sheds light on the effects of experience on retrieval from semantic autobiographical memory. Specifically, older adults possess autobiographical, personal semantic, and semantic knowledge while younger adults rely primarily on semantic knowledge of presidents (i.e., younger adults only have personal memories of a few presidents). Thus, by comparing younger and older adults' memory for the U.S. presidents, we demonstrated the effects of experience on semantic autobiographical memory processes.

The recall of U.S. presidents (semantic knowledge) can be done in the absence of any episodic information; however, rather than enhanced semantic autobiographical memory, older adults may have utilized episodic memories to support their recall of the presidents. Recollection involves the retrieval and reinstatement of contextual details of a previous episode (Yonelinas, 2002) and is often measured via introspective judgments of the phenomenological experience accompanying episodic memory retrieval. Although aging is generally associated with a decline in recollection (Folville et al., 2020; Koen & Yonelinas, 2014; Wong et al., 2012), future work should examine older adults' potential use of episodic memory to recall presidents by collecting recollection responses (i.e., "remember" judgments or vividness ratings; see Gardiner et al., 1998; Johnson et al., 1993) for each recalled president. Specifically, memory for the presidents likely reflects contributions of both semantic and episodic retrieval systems such that people have "remember" type memories of presidents in chronological order as well as a semantic understanding of the temporal order of presidential terms.

In the present study, we calculated conditional-response probabilities as a function of lag (a measure of the distance between successively recalled presidents). Retrieval patterns indicated that participants tended to recall presidents from similar eras together, suggesting that people rely on temporal-contextual and/or semantic relations to continue their search for items within the same era as a just-retrieved item. Additionally, the lag-CRPs did not have the often-observed forward asymmetry demonstrated in previous work (Healey et al., 2019; Kahana, 1996), likely because people do not always encounter presidents' names in a specific, chronological order as is seen in typical episodic free recall tasks. Moreover, the lack of the forward-biased CRP functions may result from the effects of relative distinctiveness. Specifically, the retrieval of distinct presidents may facilitate memory for other distinct presidents from a similar era, but this could occur in both directions.

Furthermore, the lag-recency effect was reduced in older adults, consistent with previous work with memory for word lists (Healey & Kahana, 2016; Kahana et al., 2002; Wahlheim & Huff, 2015). Specifically, despite the semantic nature of the paradigm used in the present study (compared with the more episodic nature of traditional free recall tasks using lists of unassociated words), the age-related deficits are consistent with the extensive literature illustrating age-related lag-recency deficits even though semantic abilities are largely preserved in older adults (e.g., Bäckman et al., 2001; Foos & Sarno, 1998; Riby et al., 2004). Additionally, we demonstrated that the lag-recency effect in the recall of the presidents was largely driven by the retrieval of presidents serving during participants' lifetimes, perhaps reflecting a critical episodic or semantic autobiographical contribution to the lag-recency effect.

The present study exemplifies the potential interplay of the mechanisms that influence the organization of retrieval such that distinctiveness and temporal contiguity effects may simultaneously impact recall. According to the distinctiveness view, participants should best recall the most accessible presidents like Trump, Obama, and Washington. Therefore, if distinctiveness enhances memory for specific presidents, regardless of their temporal position, then distinctiveness effects should offset temporal contiguity effects. However, after recalling each of these distinct presidents, these exemplars may act as a retrieval cue whereby participants can harness the benefits of accompanying semantic and temporal-contextual cues to recall additional presidents who served in office during a similar era. This may enable temporal clustering but there are likely to be era transitions as well (i.e., recalling presidents like Washington, Adams, and Jefferson then transitioning to Clinton, Bush, and Obama). Thus, distinctiveness and temporal contiguity effects may not independently affect memory.

In sum, the present study revealed dual serial position effects in older adults' retrieval from long-term memory and also demonstrated that semantic autobiographical memory may be preserved or even enhanced in older adults. Additionally, participants of all ages initiated recall with the most distinct presidents (Washington, Obama, and Trump) and generally recalled presidents from similar eras together, providing additional evidence for the relative distinctiveness principle. If distinct presidents did not facilitate the retrieval of presidents from similar eras, the CRP for each president should be the same, regardless of their serial order, such that presidents are recalled in an unorganized fashion. However, participants organized recall by using accompanying semantic and/or temporal-contextual cues of just-recalled presidents to facilitate the retrieval of presidents from similar eras, and the recall of presidents serving during participants' lives largely drove this effect. Thus, semantic temporal-contextual associations can drive semantic autobiographical memory and people of all ages likely organize retrieval from long-term memory according to familiarity and distinctiveness.

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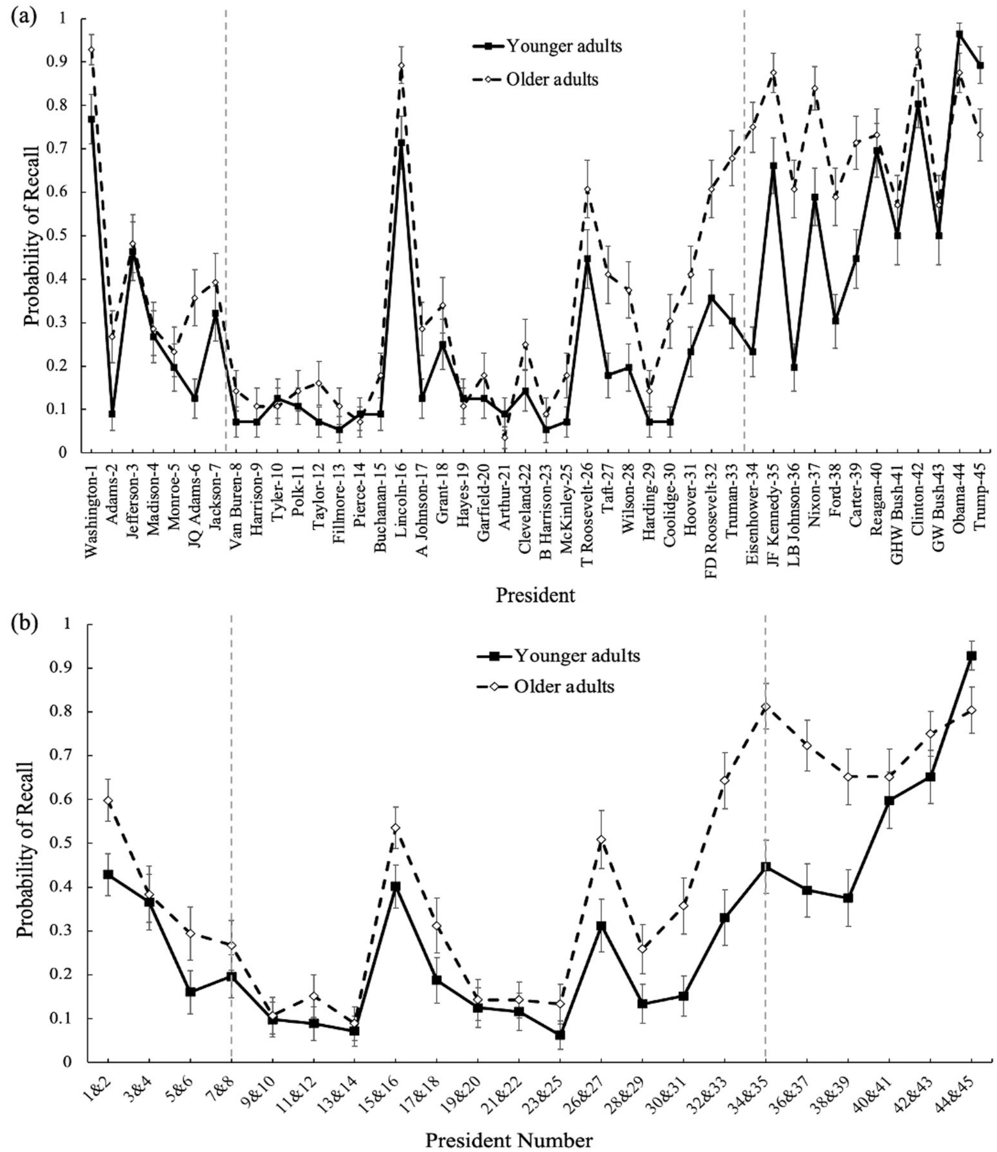

Figure 1.

Free recall probability for United States presidents as a function of the order of their term in office for each president (a) and collapsed across two adjacent positions (b). Gray dashed lines reflect the cutoffs used to distinguish primacy and recency presidents. Error bars reflect the standard error of the mean.

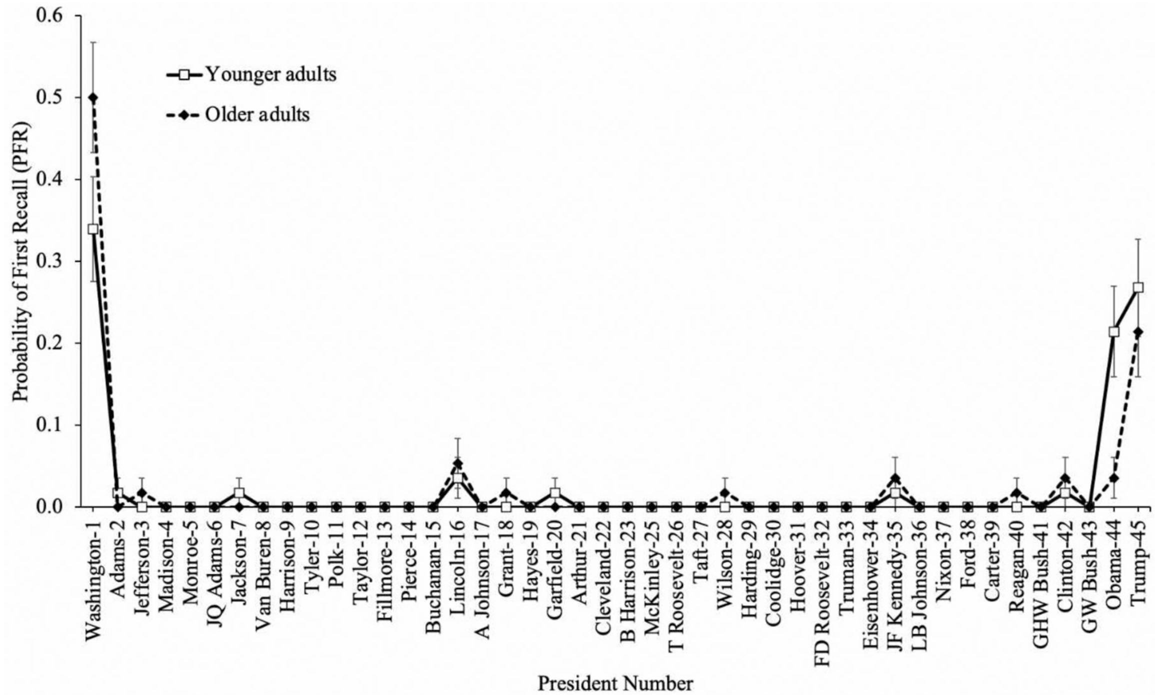

Figure 2.

Probability of first recall (PFR) as a function of presidential position in the free recall of United States presidents. Error bars reflect the standard error of the mean.

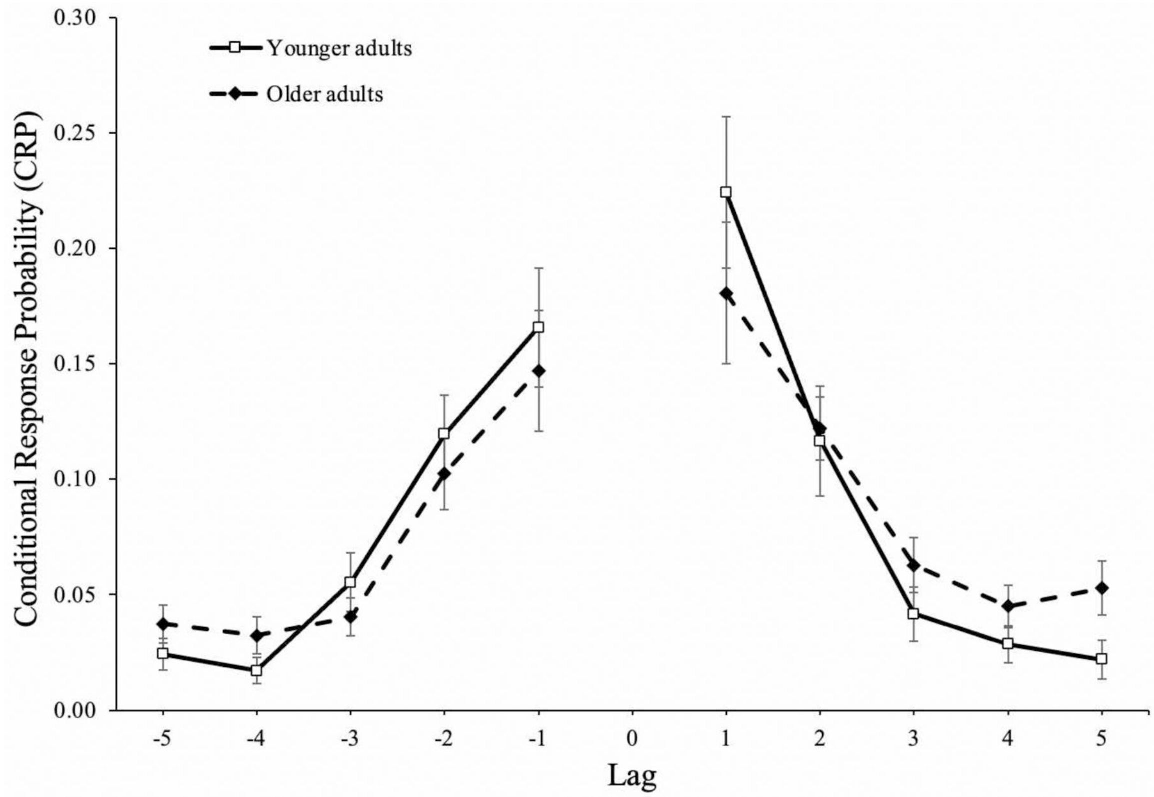

Figure 3.

Conditional response probability (CRP) functions for forward and backward transitions as a function of lag for the free recall of United States presidents. Error bars reflect the standard error of the mean.

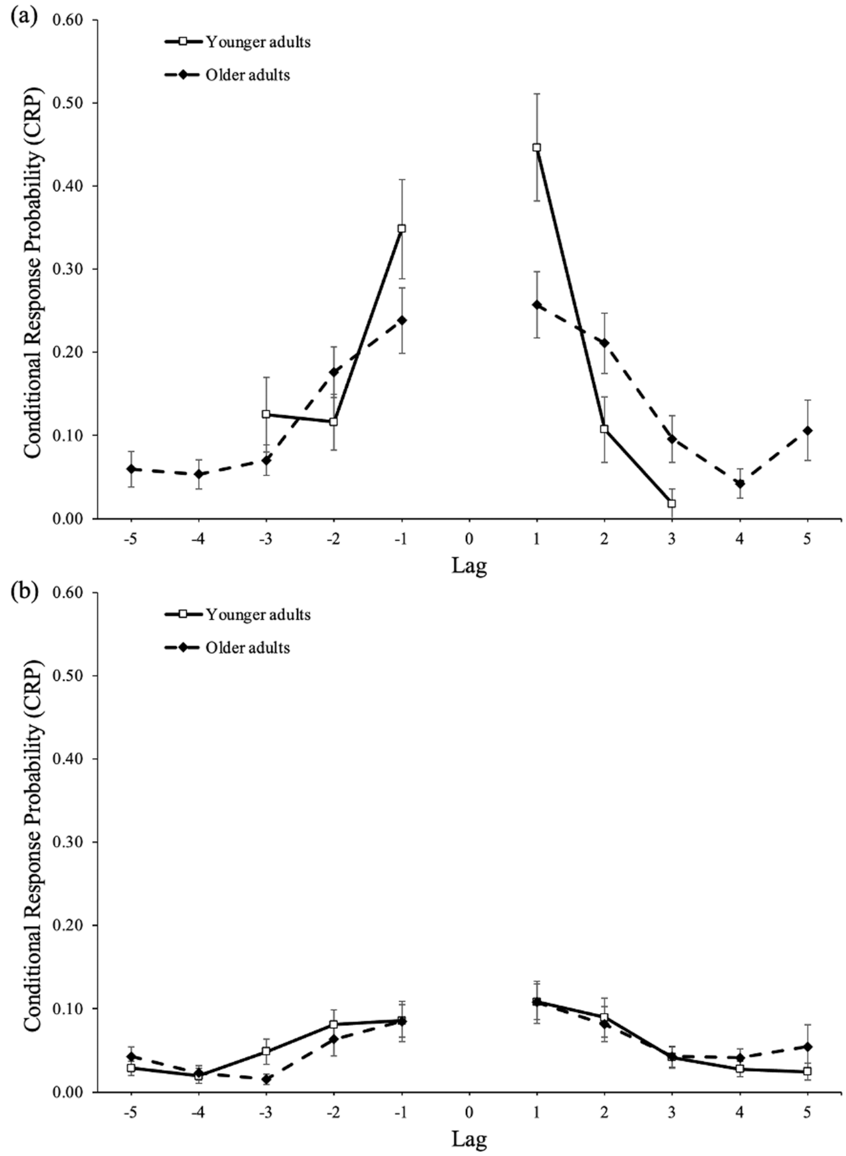

Figure 4.

Conditional response probability (CRP) functions for forward and backward transitions as a function of lag for the free recall of only United States presidencies (a) occurring during participants' lifetimes and (b) presidencies not occurring during participants' lifetimes. Error bars reflect the standard error of the mean.

Table 1.

Quadratic regression with recall for each president predicted by order of presidential term (serial position).

Group	R^2	*b1*	*b2*	*F*	*p*
Younger adults	.179	−.036	.001	268.47	< .001
Older adults	.160	−.026	.001	234.73	< .001