# Altered Episodic Memory Updating in Older Adults: Retroactive Interference from Competing Memories

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## Abstract

Memory updating represents a critical capacity for acquiring new knowledge. While extensive research has demonstrated episodic memory impairment in older adults, few studies have examined alterations in the pattern of episodic memory updating among the elderly. The present study investigated the aging effects on episodic memory updating and its underlying cognitive mechanisms, under conditions where encoding levels were equated between older and younger adults. We introduced innovations to the AB-AC memory updating paradigm, concurrently examining aging effects under both item-change and location-change conditions, and incorporated lure options during the test phase to further control for encoding-level influences. Results revealed that younger adults could store A-B and A-C memories in a segregated manner, whereas older adults exhibited greater susceptibility to retroactive memory interference—manifested as intrusions of C during A-B testing—with this interference effect being significantly more pronounced than that induced by lure stimuli. These findings indicate that when encoding levels are matched between younger and older adults, memory updating in younger adults is accomplished through memory differentiation, while older adults experience greater retroactive interference from competing memories.

## Full Text

### Altered Episodic Memory Updating in Older Adults: Retroactive Interference from Competing Memories

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## Abstract

Memory updating is a crucial ability for acquiring new knowledge. While extensive research has demonstrated age-related impairments in episodic memory, few studies have examined how aging alters the pattern of episodic memory updating. The present study investigated age-related changes in episodic memory updating and their underlying cognitive mechanisms while equating encoding levels between older and younger adults. We adapted the AB-AC memory updating paradigm to examine aging effects under both item-change and location-change conditions, and further introduced lure options during the test phase to exclude potential encoding-level confounds. The results revealed that younger adults could store A-B and A-C memories in a segregated manner, whereas older adults experienced greater retroactive interference, evidenced by intrusions of C during A-B testing. This interference effect was significantly stronger than that induced by lure stimuli. These findings indicate that when encoding strength is matched between age groups, younger adults implement memory updating through memory differentiation, while older adults are more susceptible to retroactive interference from competing memories.

**Keywords:** memory updating, aging, item memory, source memory, retroactive interference

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## 1. Introduction

Age-related memory decline poses significant challenges to older adults' daily functioning, with episodic memory showing particularly pronounced deterioration (Cansino, 2009; Nyberg et al., 2003; Old & Naveh-Benjamin, 2008; Vestergren & Nilsson, 2011). Episodic memory encompasses the temporal and spatial contextual memory of everyday experiences (Tulving, 1972), comprising both item memory related to event content and source memory concerning event context. Compared to item memory, older adults exhibit greater difficulty in judging the source of events (Craik, 1986). For instance, an older adult might remember a friend but fail to recall where and when they met. Recent research has predominantly examined age-related changes in episodic memory from an encoding perspective, highlighting impairments in memory binding abilities (e.g., Jacoby et al., 2015; Stawarczyk et al., 2020; see meta-analysis by Old & Naveh-Benjamin, 2008). However, few studies have investigated retrieval pattern differences between younger and older adults during episodic memory updating. The present study examined how aging alters retrieval patterns when older adults undergo item memory (or location memory) updating, while controlling for encoding levels across age groups.

Memory updating is a reconstructive process in which new information interacts with existing memory representations (Dudai, 2012; Lee, 2009). This process typically occurs when new memories emerge, often studied using the AB-AC memory updating paradigm (Hupbach et al., 2007; Xue, 2018). The fundamental logic of this paradigm involves establishing two sets of paired associations. Participants first learn A-B associations on Day 1, then form A-C associations on Day 2, and finally undergo testing of both A-B and A-C memory strengths on Day 3. Under these competitive memory conditions, individuals may exhibit either (1) memory differentiation or (2) memory interference. Memory differentiation indicates that individuals can orthogonalize new memories from pre-existing ones, separating newly formed memory traces from existing neural representations with minimal interference from overlapping or competing memories (Hulbert & Norman, 2015; Norman & O' Reilly, 2003). In the AB-AC paradigm, this manifests as comparable performance on A-B and A-C tests. Memory interference, conversely, occurs when overlapping memory components disrupt retrieval (Anderson, 2003; Anderson & Neely, 1996; Runquist, 1975). One source of interference stems from competition between overlapping memories sharing the same retrieval cue (A-B and A-C) (see Anderson & Neely, 1996). When C is erroneously retrieved during A-B memory testing (or B during A-C testing), these intrusions are termed memory intrusions—a key metric for investigating memory interference (Hupbach et al., 2007). The directional nature of memory updating interference remains unclear, with the question of whether "new memories hinder old memory retrieval" or "old memories affect new memory learning" depending on research goals and methods. Proactive interference (PI) in episodic memory refers to old memories impeding current memory encoding, typically occurring during the encoding phase (e.g., Burton et al., 2019; Howe et al., 2020; Zancada-Menendez et al., 2015). Retroactive interference (RI), in contrast, emphasizes how new memories hinder old memory retrieval, suggesting that target memory recall is disrupted by existing memory traces when retrieval cues are presented (Anderson, 2003).

The associative independence hypothesis (Burton et al., 2017; Burton et al., 2019) posits that memory possesses differentiation capabilities. In studies where young participants learn A-B and A-C word-word associations and are subsequently asked to recall both B and C in relation to A, research has found that younger adults retrieve A-B and A-C associations in a largely independent, non-interfering manner. Meanwhile, the complementary learning systems framework (CLS; McClelland et al., 1995; Norman & O' Reilly, 2003) suggests that if individuals cannot orthogonalize different memory representations, old information will be overwritten by newly learned input—a process achievable through pattern separation in the hippocampus. Pattern separation is the process of storing similar input information in non-overlapping ways and represents a crucial feature of memory updating (McClelland et al., 1995; Norman, 2010; Norman & O' Reilly, 2003). Extensive research indicates that older adults exhibit structural and functional hippocampal damage (Ira et al., 2003; West, 1993), which may impair their pattern separation function and consequently cause interference between multiple memory representations (Holden et al., 2012). Based on this evidence, we hypothesized that with equivalent A-B and A-C memory encoding, most younger adults would achieve memory updating through memory differentiation—segregating A-B and A-C connections—whereas older adults, with impaired pattern separation abilities, would exhibit memory interference when confronted with competing memory content (A-B and A-C). However, since the AB-AC paradigm involves both new memory encoding and competitive memory retrieval, it remains unclear whether older adults experience more proactive or retroactive interference during retrieval on Day 3.

To minimize encoding-related confounds, we improved the AB-AC memory updating paradigm through two key modifications: (1) manipulating learning trials across age groups and (2) introducing lure stimuli. Recent research by Howe et al. (2020) demonstrated that older adults require approximately twice as many learning trials as younger adults to achieve comparable encoding strength. Drawing on previous literature and pilot data, we set older adults' learning trials at double those of younger adults. Additionally, we incorporated lure stimuli—options similar to but distinct from target stimuli—into the traditional AB-AC test framework. Lure stimuli serve two purposes: (1) they further exclude encoding effects by demonstrating that if participants select competing stimuli over lure stimuli during testing, memory errors stem more from competitive memory interference than from encoding granularity; and (2) they reveal whether participants employ memory strategies during encoding, as semantic memories may automatically activate when viewing scenes and assist selection during testing. No prior research has compared the relative contributions of lure stimulus similarity effects and competitive memory interference effects on age-related memory updating. Including lure stimuli in our design helps clarify the cognitive aging mechanisms underlying memory updating.

In summary, while controlling for encoding levels between age groups, this study examined differences in item and location updating patterns between older and younger adults to reveal the cognitive aging mechanisms involved in retrieving competing A-B and A-C memories. We innovated the AB-AC paradigm by having participants learn two sets of scene-item (or location) connections on separate days, with scenes remaining constant as the "A" stimulus (see [Figure 1: see original paper]). Testing occurred at two time points—short-term (1 day later) and long-term (3 days later)—to investigate potential delay effects. The test option framework included target options (correct answers: B in A-B tests and C in A-C tests), competitor options (competing answers: C in A-B tests and B in A-C tests), and lure options (answers similar to targets: B' in A-B tests and C' in A-C tests; see [Figure 2: see original paper]). If participants correctly selected B more often in A-B tests and C more often in A-C tests, with no significant difference in retention between A-B and A-C memories, this pattern would indicate memory differentiation. Conversely, if participants more frequently selected C in A-B tests (C memory intrusion) while showing fewer B intrusions in A-C tests, this would support retroactive interference in memory updating; the opposite pattern would support proactive interference.

## 2.1 Participants

We used G*Power 3.1 (Faul et al., 2007) to estimate sample size. With Cohen' s d = 0.8, statistical power = 0.8, and confidence level = 95%, the required sample size was 21 participants per group. We recruited 30 younger adults and 30 older adults, exceeding the minimum requirement. All older adults completed the Montreal Cognitive Assessment (MMSE; Folstein et al., 1975) and were included if they scored above 24 and had at least 6 years of education. Detailed demographic information is presented in . Younger and older adults differed significantly in education years, which we controlled as a covariate in subsequent analyses. All participants had normal or corrected-to-normal vision. One older adult was excluded for performing at chance level on both item and location encoding tests, failing to meet the average encoding criterion. In the confidence rating analysis, we excluded one older adult whose subjective ratings exceeded three standard deviations of the older adult group. Additionally, Day 2 encoding test data were missing for one older adult. All participants provided informed consent, and the study was approved by the Ethics Committee of the School of Psychology, Southwest University (No. H21040).

**Table 1** Demographic Information for Younger and Older Adults

| Variable | Younger Adults (n = 30) | Older Adults (n = 30) | t/ $^2$ | p |
|---|---|---|---|---|
| Age | 18.70 ± 0.79 | 64.72 ± 5.04 | -48.01 | < 0.001*** |
| Education (years) | 12.67 ± 0.80 | 10.76 ± 2.80 | 27.21 | < 0.001*** |
| Gender (male %) | - | - | 2.70 | < 0.001*** |

Note: Gender ratio was analyzed using $^2$ test. ***p < 0.001.

## 2.2 Experimental Materials and Procedure

We employed a modified AB-AC memory updating paradigm. Specifically, "A" represented "scenes," while "B" and "C" represented two "items" (or "locations" in the location-change condition) paired with each scene. In the item-change condition, participants established scene-item connections on Day 1, and on Day 2, the items paired with scenes changed while locations remained constant (see [Figure 1: see original paper]). In the location-change condition, participants formed scene-item location connections on Day 1, and on Day 2, the item locations changed while the items themselves remained constant (see [Figure 1: see original paper]).

Experimental stimuli consisted of 36 images from six different indoor scenes (kitchen, dining room, living room, bedroom, bathroom, and study) and 108 item stimuli. Fifty-four items served as target stimuli, while the remaining 54 were similar lure stimuli. We standardized all stimuli for resolution (1024$×$768), contrast, and brightness. Additionally, we matched the compatibility (M = 4.12, M = 4.14, t(69.98) = -0.17, p = 0.864) and familiarity (M = 3.94, M = 3.96, t(69.65) = -0.02, p = 0.986) of A-B and A-C scenes and items to minimize semantic influences (see Supplementary Table S1).

**[Figure 1: see original paper]** Schematic illustration of experimental materials. The left column shows scene-item/location pairings from Day 1 A-B learning, and the right column shows pairings from Day 2 A-C learning. The top row depicts item-change trials, and the bottom row depicts location-change trials.

Participants visited the laboratory four times (see [Figure 2a: see original paper]): on Days 1, 2, 3, and 5 (with a 48-hour interval between Days 3 and 5). On Day 1, participants learned 36 scene-target (or location) pairings (A-B encoding). On Day 2, they completed A-C encoding, with half the trials involving item changes and half involving location changes relative to Day 1. On Days 3 and 5, participants completed A-B (based on Day 1 learning) and A-C (based on Day 2 learning) memory tests. Test order was counterbalanced across participants. To ensure task comprehension, participants completed practice trials using scenes and items not included in the formal experiment.

**Day 1: A-B Encoding.** Participants learned 36 A-B pairings. Each trial proceeded as follows: after a 1000 ms fixation point, an item and its name appeared for 1000 ms. Subsequently, the item placed within a scene was presented for 2000 ms, allowing participants to learn the scene-target/location pairing. To ensure effective encoding, the item within the scene was then highlighted with a red box for 1000 ms. To equate encoding levels across age groups, and based on previous literature (Howe et al., 2020) and pilot data, older adults completed twice as many learning trials as younger adults. Younger participants studied the materials twice, while older participants studied them four times. Following A-B learning, an encoding test ensured equivalent encoding across groups, using the same procedure as the Day 3 A-B test.

**Day 2: A-C Encoding.** To temporally match A-B and A-C learning intervals, participants first reviewed A-B pairings without testing. Prior research indicates that reactivating A-B memories before A-C learning facilitates updating by keeping associative memories active (Hupbach et al., 2007; Ye et al., 2020). After a 5-minute rest, participants learned A-C pairings using the same scenes as Day 1, with half the trials involving item updates and half involving location updates. Older adults again completed twice as many learning trials as younger adults. An encoding test followed A-C learning to ensure equivalent encoding strength across age groups, using the same procedure as the Day 3 A-C test.

**Day 3: Memory Testing (1-day delay).** Participants completed A-B and A-C tests, with A-B testing requiring recognition based on Day 1 learning and A-C testing based on Day 2 learning. The two tests were separated by a 5-minute interval, with order counterbalanced across participants. In item-change tasks, the encoding scene appeared at the top of the screen, and participants selected the matching item. In location-change tasks, the encoding scene appeared with three numbered locations, and participants selected the correct location where the item had appeared during encoding. After each selection, participants rated their confidence on a 6-point Likert scale (1 = very uncertain to 6 = very certain).

Response options included three categories: target (correct answer), competitor, and lure. Target options were B in A-B tests and C in A-C tests. Competitor options were C in A-B tests and B in A-C tests. Lure options were items or locations similar to but distinct from targets (B' in A-B tests and C' in A-C tests; see [Figure 2b: see original paper]).

**Day 5: Memory Testing (3-day delay).** After a 48-hour interval, participants repeated A-B and A-C tests on Day 5, following the same procedure as Day 3. Test order was counterbalanced both across participants and across time (e.g., if a participant completed A-B first on Day 3, they completed A-C first on Day 5).

**[Figure 2: see original paper]** Experimental procedure and test-phase option framework. (a) Experimental flow: On Day 1, participants learned A (scene)-B (item/location) associations. On Day 2, they reviewed A-B associations before learning new A-C associations. All participants returned on Days 3 and 5 to complete A-B tests (based on Day 1 learning) and A-C tests (based on Day 2 learning). (b) Schematic of test-phase options. Target options are B in A-B tests and C in A-C tests; competitor options are C in A-B tests and B in A-C tests; lure options are items or locations similar to targets (B' in A-B tests and C' in A-C tests).

The experimental program was written in E-Prime 2.0. Stimuli were presented on a 19-inch CRT color monitor with a resolution of 1280$\times$1024 and a refresh rate of 60 Hz.

## 2.4 Data Analysis

We conducted data analysis using R (version 4.0.4; R Core Team, 2021). Given that Day 2 involved two change types (item or location), we calculated response proportions for items in the item-change condition and for locations in the location-change condition. First, independent samples t-tests examined whether encoding levels were matched between age groups after A-B and A-C learning. We then calculated the proportions of target, competitor, and lure selections in both item-change and location-change conditions. A 2 (age: younger vs. older) × 2 (association: A-B vs. A-C) × 3 (option category: target vs. competitor vs. lure) × 2 (time: Day 3 vs. Day 5) repeated measures ANOVA tested age differences in memory updating patterns, with age as a between-subjects factor and association, option category, and time as within-subjects factors. We conducted simple effects analyses for significant interactions with Bonferroni correction for multiple comparisons. As our focus was on age-related mechanisms of memory updating, we only performed simple effects analyses for effects interacting with age. When age-related three-way interactions were significant, we present simple effects for the three-way interaction in the main text and age-related two-way interactions in the supplementary materials (Table S2). Finally, we examined age-group differences in subjective confidence ratings for item-change and location-change trials and computed subject-level correlations between memory accuracy and confidence ratings. Given the small sample size and negative skew in older adults’ ratings, we used Spearman correlations.

## 3.1 Encoding Level Verification

Welch’ s t-tests compared encoding performance between age groups. On Day 1, A-B item encoding accuracy did not differ significantly between younger and older adults, t(56.65) = 1.08, p = 0.286, Cohen’s d = 0.69, 95% CI = [0.16, 1.21]. However, A-B location memory strength differed significantly, with younger adults outperforming older adults, t(53.67) = 2.43, p = 0.018, Cohen’ s d = 0.63, 95% CI = [0.11, 1.16].

On Day 2, younger and older adults showed no significant differences in A-C item memory encoding, t(54.60) = 1.15, p = 0.254, Cohen’ s d = 0.30, 95% CI = [0.22, 0.82], nor in A-C location memory encoding, t(55.79) = 2.00, p = 0.511, Cohen’ s d = 0.53, 95% CI = [0.00, 1.05]. Encoding levels were largely matched between younger and older adults (except for A-B location memory), demonstrating that our encoding manipulation was generally effective.

## 3.2 Episodic Memory Updating Results

Repeated measures ANOVA results for item and location memory tasks are presented in . Both item-change and location-change conditions showed significant age × category × association interactions (item-change: F(1.27, 72.32) = 14.20, $p < 0.001$, $p^2 = 0.20$, 90% CI = [0.09, 0.30]; location-change: F(1.31, 74.58) = 9.96, $p < 0.001$, $p^2 = 0.15$, 90% CI = [0.05, 0.24]). The full ANOVA indicated that the time variable (Day 3 vs. Day 5) did not significantly affect the memory updating patterns under investigation.

**Table 2** Repeated Measures ANOVA Results

| Effect | Item Change | Location Change |
|---|---|---|
| Age × Association | 90% CI [0.00, 0.15] | 90% CI [0.00, 0.00] |
| Age × Category | < 0.001*** [0.88, 0.92] | < 0.001*** [0.81, 0.88] |
| Age × Time | [0.00, 0.11] | [0.00, 0.00] |
| Association × Category | < 0.001*** [0.24, 0.45] | < 0.001*** [0.25, 0.46] |
| Association × Time | [0.00, 0.15] | [0.00, 0.00] |
| Category × Time | < 0.001*** [0.09, 0.30] | 0.001** [0.03, 0.20] |
| Age × Association × Category | < 0.001*** [0.09, 0.30] | < 0.001*** [0.05, 0.24] |
| Age × Association × Time | [0.00, 0.18] | [0.00, 0.00] |
| Age × Category × Time | [0.00, 0.12] | 0.005** [0.02, 0.17] |
| Association × Category × Time | [0.00, 0.05] | [0.00, 0.03] |
| Age × Association × Category × Time | < 0.001*** [0.09, 0.30] | 0.002** [0.03, 0.19] |

Note: 90% CI = 90% confidence interval for $p^2$; *$p < 0.05$,* ***$p < 0.01$,*** $p < 0.001$.

Simple effects analysis of the age × association × category three-way interaction revealed distinct patterns. Younger adults showed consistent memory updating patterns across item-change ([Figure 3a: see original paper]) and location-change ([Figure 3b: see original paper]) conditions, with no significant differences in target selection between A-B and A-C tests (item-change: t(57) = -1.98, p = 0.053; location-change: t(57) = -0.24, p = 0.812) and no differences in competitor selection (item-change: t(57) = -0.31, p = 0.756; location-change: t(57) = -0.735, p = 0.465). However, younger adults selected more lure options in A-B tests than in A-C tests (item-change: t(57) = 4.24, p < 0.001; location-change: t(57) = 2.05, p = 0.045). These results suggest that younger adults could segregate A-B and A-C associations, exhibiting minimal competitive memory intrusions and no differential proactive or retroactive interference, thus demonstrating memory differentiation during updating.

Older adults showed markedly different patterns in both item-change ([Figure 3c: see original paper]) and location-change ([Figure 3d: see original paper]) conditions. Specifically, A-C memory accuracy (target selection) was higher than A-B memory accuracy (item-change: $t(57) = -6.75$, $p < 0.001$; location-change: $t(57) = -3.88$, $p < 0.001$). Critically, older adults selected competitor options (C) in A-B tests more frequently than competitor options (B) in A-C tests (item-change: $t(57) = 5.65$, $p < 0.001$; location-change: $t(57) = 4.55$, $p < 0.001$). Lure selection did not differ significantly between A-B and A-C tests (item-change: $t(57) = -0.31$, $p = 0.756$; location-change: $t(57) = -0.88$, $p = 0.382$). These findings demonstrate that older adults experienced greater retroactive interference during episodic memory updating, specifically showing intrusions of competing memory C during A-B testing.

**[Figure 3: see original paper]** Memory test performance for (a) younger adults' item memory, (b) younger adults' location memory, (c) older adults' item memory, and (d) older adults' location memory.

## 3.3 Subjective Memory Evaluation Performance

Independent samples t-tests on confidence ratings revealed that older adults' confidence scores were significantly higher than younger adults' in both item-change trials ($t(89.57) = 2.20$, $p = 0.031$, Cohen' s $d = 0.34$, 95% CI = [0.03, 0.64]) and location-change trials ($t(89.57) = 6.67$, $p < 0.001$, Cohen' s $d = 1.01$, 95% CI = [0.69, 1.32]). We also examined individual-level correlations between memory accuracy and subjective confidence. [Figure 4: see original paper] shows the relationship between confidence ratings and memory performance for both age groups. Younger adults exhibited significant positive correlations between memory performance and confidence in both item-change ($r = 0.55$, $p = 0.002$) and location-change ($r = 0.60$, $p < 0.001$) trials, indicating higher confidence was associated with better accuracy. In contrast, older adults showed no significant linear relationship between confidence and performance (item-change: $r = -0.11$, $p = 0.594$; location-change: $r = 0.07$, $p = 0.703$). Fisher' s Z transformations comparing the correlation coefficients revealed significant differences between age groups, with younger adults showing stronger confidence-accuracy correlations than older adults (item-change: $z = 2.23$, $p = 0.026$; location-change: $z = 2.27$, $p = 0.023$).

**[Figure 4: see original paper]** Correlations between subjective confidence ratings and memory performance for (a) item-change and (b) location-change trials in younger and older adults. Box plots above the correlation plots show confidence rating distributions.

Most aging research on episodic memory has focused on encoding processes, with few studies investigating episodic memory updating and the cognitive aging mechanisms of competitive memory retrieval. Using ecologically valid life scene images and controlling for encoding strength across age groups, we examined the mechanisms underlying age-related changes in item and location memory updating. We found consistent memory updating patterns across item-change and location-change conditions when encoding was matched: younger adults could form new memories while preserving old ones—they segregated A-B and A-C memories—whereas older adults experienced retroactive interference from competing memories, evidenced by significantly more C intrusions in A-B tests than B intrusions in A-C tests. This behavioral pattern showed long-term persistence, lasting at least three days.

Younger adults' tendency toward segregated storage aligns with previous research (e.g., Burton et al., 2017; Burton et al., 2019). Existing evidence supports that younger adults' A-B and A-C representations can coexist, indicating successful pattern separation—the process of storing similar memories as distinct representations. Conversely, failure to orthogonalize memory representations leads to old information being overwritten by new input, with impaired pattern separation causing memory interference. Our study required participants to update scene-item/location connections across two days, a process necessitating pattern separation. The results suggest younger adults maintained relatively intact pattern separation abilities, while older adults showed pattern separation deficits. Pattern separation primarily depends on the dentate gyrus (DG) and its projections to hippocampal CA3 subfields (see review by Yassa & Stark, 2011). However, the DG is age-sensitive (Small et al., 2002; West, 1993), and Yassa et al. (2011) found correlations between CA3/DG hyperactivity and aging, suggesting age-related memory decline may stem from hippocampal pattern separation deficits. While previous behavioral pattern separation studies used incidental encoding tasks to differentiate targets from lures (e.g., Bakker et al., 2008; Stark et al., 2013), our study extends these findings by incorporating competitive memories in a memory updating paradigm to reveal age effects on pattern separation. Notably, we tested participants 24 and 72 hours after Day 2 learning and found consistent memory patterns across Days 3 and 5, confirming that younger adults' memory differentiation and older adults' retroactive interference exhibit long-term effects.

In addition to target and competitor options, we included lure options to further control for encoding effects. Since lure options are similar to targets, participants who cannot encode details precisely would be susceptible to lure interference during testing. We found that younger adults selected lure options more frequently in A-B tests than A-C tests across both change conditions (B' > C' ), possibly reflecting younger adults' memory strategies. Younger adults may more readily recruit semantic information to aid memory (Mohanty et al., 2016), activating corresponding semantic memories during testing to facilitate retrieval. Given that A-B memory traces are weaker than A-C traces, younger adults may have selected semantically similar lures more often in A-B tests. In contrast, older adults' memory decline appeared more influenced by competitor stimuli than lure stimuli, with no significant difference in lure selection between A-B and A-C tests. This further suggests that older adults' memory updating deficits stem more from competitive memory interference than from impaired encoding granularity.

Our analysis of subjective confidence ratings and individual differences revealed that older adults' confidence ratings were uncorrelated with memory performance and were significantly higher overall than younger adults' ratings. Similar findings have been observed in aging research (Fandakova et al., 2013; Jacoby & Rhodes, 2006; Shing et al., 2009), potentially explained by two factors: First, subjective evaluation is closely linked to the metacognitive memory system (Brewer & Wells, 2006), which becomes impaired with age (Palmer et al., 2014), particularly when assessing specific memory details (Dodson et al., 2007). In our study, recalling items or locations within complex scenes required resource-demanding metacognitive monitoring, and older adults showed inaccurate self-assessment of their performance. Second, to avoid negative social evaluation (e.g., "older adults have poor memory" ), older adults may exhibit a tendency toward favorable self-ratings (Dodson & Krueger, 2006; Shing et al., 2009).

This study has several limitations. First, given the similarity between target and lure stimuli, lure options might serve as "cues" for targets. Future studies could add a competitor-lure option (similar to the competitor) to further exclude option-framework interference. Indeed, our subsequent research using a similar AB-AC paradigm to examine prior knowledge effects on older adults' episodic memory updating included competitor-lure options and yielded similar results, confirming that older adults' retrieval failures stem more from competitive memory interference than lure stimuli. Second, baseline A-B location memory encoding on Day 1 was not perfectly matched between age groups. However, all other three conditions successfully matched encoding levels, and lure option results further exclude encoding-level confounds. Finally, our design cannot verify reconsolidation effects. Substantial evidence indicates that reactivated memories enter a plastic state (Lee et al., 2017), during which new information can be integrated into old memory traces—a phenomenon known as memory reactivation (Hupbach et al., 2007; Scully et al., 2017). In our paradigm, A-B memories were reactivated before A-C learning on Day 2, rendering them labile and susceptible to being overwritten by A-C memories. Although older adults showed numerous C intrusions in A-B tests, future research could add a non-reactivation condition to specifically examine aging effects on reconsolidation (see Howe et al., 2020).

In conclusion, our innovative AB-AC memory updating paradigm revealed age-related changes in memory updating patterns across item-change and location-change conditions. With encoding levels matched between age groups, younger adults updated memories through differentiation, achieving pattern separation between A-B and A-C memories, whereas older adults experienced greater retroactive interference from competing memories, evidenced by increased C intrusions in A-B memories. This age effect was consistent across item and location changes and showed long-term persistence (lasting at least three days).

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