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The Role of Reminding in Retroactive Effects of Memory for Older and Younger Adults

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Retroactive interference refers to the impairing effects of new learning on earlier memories. The memory-for-change framework posits that being reminded of earlier information when learning new information can alleviate such retroactive interference and lead to facilitation. Such effects have been shown in younger adults, but the extent to which remindings play a role in retroactive effects of memory for older adults has not been examined. We address this issue here in two experiments using variants of an A–B, A–C paired associate paradigm. Participants studied two lists containing associated word pairs that: repeated across lists (A–B, A–B), included the same cue with a changed response in List 2 (A–B, A–C), or only appeared in List 1 (A–B), and then completed a cued-recall test of List 1. Participants reported List 1 reminding during List 2 study and recollection of reminding at test. Neither age group showed retroactive interference in overall List 1 recall, but younger adults showed poorer source monitoring by producing more List 2 intrusions onto List 1 recall than older adults. For both age groups, reminding was associated with retroactive facilitation for List 1 recall, whereas the absence of reminding was associated with retroactive interference. The benefits associated with reminding and recollection of reminding were greater for younger than older adults, partly because younger adults were able to recollect remindings more often than older adults. Together these results implicate a role for reminding in retroactive effects of memory that is more facilitative for younger than older adults.

Keywords: cognitive aging, episodic memory, reminding, recollection, interference

Suppose that a patient sees a new physician after an increased dosage of medication caused negative side effects. To determine what dosage is appropriate, the physician asks about the original dosage, but the patient can only remember the current dosage. This memory failure is an example of *retroactive interference*, whereby memory for the current dosage impaired memory for the original dosage. Memory errors resulting from retroactive interference such as these may be more likely to occur in older adulthood (for reviews, see Kane & Hasher, 1995; Kausler, 1994). In this example, the diminished ability to remember the original dosage could prolong the process of finding the appropriate dosage, resulting in longer periods of adverse side effects. Thus, an important goal of cognitive aging research is to identify the mechanisms underlying age differences in retroactive interference. This can lead to more effective strategies for avoiding the negative effects of interference in memory. In the present study, we used variants of the A–B, A–C paradigm to examine the extent to which remindings that occur when studying new information may counteract retroactive interference for older and younger adults.

We examined this issue using variants of the A–B, A–C paradigm because older adults have often shown greater susceptibility to retroactive interference under such conditions (Arenberg, 1967; Traxler, 1973). In this paradigm, participants are sometimes instructed to study two lists of word pairs that contain some pairs that repeat across lists (A–B, A–B), control pairs that have no relationship across lists (A–B, C–D), and some that have the same cue with a different response in List 2 (A–B, A–C). Then, participants are asked to recall responses from List 1. Retroactive interference is observed when recall of the first list response (B) is poorer for A–B, A–C pairs than recall for control pairs. In the prior studies showing that older adults are more susceptible to retroactive interference than younger adults, the predominant explanation for such age differences is that older adults' have an impaired ability to inhibit nontarget information (for a review, see Kane & Hasher, 1995).

The idea that older adults experience an inhibitory deficit has been forwarded primarily by Hasher and colleagues (e.g., Hasher & Zacks, 1988; Lustig, Hasher, & Zacks, 2007). The theory proposes that inhibitory functions are used to prevent distracting information from entering working memory, remove irrelevant information that does enter working memory, and suppress prepo-

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tent or habitual responses. The theory assumes that efficient processing takes place when one can successfully engage inhibition to suppress information from the past or the present that is attracting attention away from the current goal or stimuli to be processed (for a review, see Lustig, Hasher, & Tonev, 2001). Older adults are presumed to process new information less efficiently because they experience an inhibition deficit, which allows more irrelevant or distracting information to enter working memory. This leads to increased response competition at retrieval, and subsequently, impairs memory performance. In studies testing this account, Hasher and colleagues (e.g., Connelly, Hasher, & Zacks, 1991; Hamm & Hasher, 1992; Hartman & Hasher, 1991; Hasher, Quig, & May, 1997) have shown that older adults are less likely than younger adults to ignore distracting information and more likely to retrieve it. When applied to interference-based memory paradigms, the inhibitory deficit theory posits that one must inhibit the nontarget list both during encoding and retrieval in order to successfully remember the target list responses (for a discussion of this issue, see Lustig et al., 2001).

In contrast to this perspective, we argue that inhibition of competing information during encoding and retrieval is not always necessary to successfully recall earlier-studied information. Specifically, we argue that one need not invoke inhibition deficit theory to understand age differences in A–B, A–C paired associate paradigms when the task allows for and encourages integrative encoding of competing information. This argument is partly based on evidence from other paradigms showing that integrative encoding can counteract interference effects in both older and younger adults. For example, consider studies on the fan effect. Those studies often show that response time to retrieve facts associated with a common cue increases as the number of encoded facts increases, which indicates interference effects in memory (e.g., Anderson, 1974). However, if one can integrate the facts into one, more complex representation, such interference is eliminated (Myers, O'Brien, Balota, & Toyofuku, 1984; Radvansky, Spieler, & Zacks, 1993; Radvansky & Zacks, 1991). Both older and younger adults can engage in such integrative processing, which results in comparable avoidance of this sort of interference (e.g., Radvansky, Zacks, & Hasher, 1996, 2005).

Despite evidence suggesting that both age groups can leverage integrative encoding to reduce interference, no studies to our knowledge have examined the role of integrative encoding in retroactive effects of memory in older and younger adults using the A–B, A–C paradigm. This is surprising given that the prominent theoretical perspective of age differences in A–B, A–C recall, inhibition deficit theory (e.g., Hasher & Zacks, 1988), is somewhat controversial (for a review see, Lustig et al., 2007). We addressed this gap here by examining whether participants could improve memory for original information in an A-B, A-C paradigm in part by retrieving earlier-learned pairs while studying new pairs with shared cues and changed responses. To explain how such mechanisms may improve memory, we adopted the perspective of the memory-for-change (MFC) framework (Jacoby, Wahlheim, & Kelley, 2015; Wahlheim & Jacoby, 2013).

The MFC framework combines the recursive remindings hypothesis (Hintzman, 2011) with dual-process theory (Jacoby, 1991) to argue that study phase retrievals (i.e., remindings) can eliminate interference and sometimes lead to facilitation by promoting integrative encoding. The framework was originally developed to account for proactive effects of earlier-learned information on memory for more recent information. Under such conditions, the framework proposes that a currently perceived stimulus can trigger a reminding of an earlier memory that includes overlapping features. Bringing the earlier memory into working memory along with the current one enables them to be integrated, along with the reminding that links them, into a configural representation. The reminding process allows earlier memories to receive retrieval practice benefits, making them more accessible in memory. The increased accessibility of information from nontarget sources can be opposed if the configural representation formed during List 2 is recollected later at test. This recollection allows access to both responses and the temporal order in which they occurred, leading to a recall benefit for more recent information. However, if this configural representation is not recollected at test, the accessibility of the earlier memory enhanced by retrieval practice leads to proactive interference. The framework posits that overall recall of changed information is comprised of both facilitation and interference effects that depend on the frequencies of remindings and later recollection of remindings.

Important for the present study, this mixture of effects has been shown in experiments examining the role of reminding in proactive effects of memory for older and younger adults (e.g., Wahlheim, 2014; Wahlheim & Zacks, 2019). Those studies showed that older adults were more susceptible to memory impairment from response competition primarily because they detected and recollected fewer changes than younger adults. We extend on that work in the present study by examining whether similar age differences exist under retroactive experimental conditions. Under such conditions, the MFC framework predicts that remindings will improve memory for earlier-learned information through retrieve practice. In contrast to proactive experimental conditions, recollection of reminding is not required to oppose the accessibility of List 1 responses because those responses are targets under such conditions. Nevertheless, retrieval of existing memories may still be further enhanced when configural representations can be recollected at test. Recollecting those representations could improve retrieval of existing memories beyond reminding alone when retrieval of more recent information serves as an additional retrieval cue for earlier information (Negley, Kelley, & Jacoby, 2018) or when the representation preserves temporal order in a manner shown to support list discrimination (Jacoby, Wahlheim, & Yonelinas, 2013). When remindings do not occur in List 2, recall of earlier memories should be poorest because they do not receive retrieval practice benefits.

Support for these predictions was shown in two recent studies of retroactive effects of memory for younger adults. In the first study, Jacoby et al. (2015, Experiment 1) examined the effects of controlled remindings on List 1 recall in an A–B, A–C paradigm, where participants studied two lists that included word pairs for which cues remained the same and responses changed between or within lists (between-list and within-list A–B, A–C, respectively), and control pairs that only appeared in List 1. During List 2 study, one group looked for changes originating in either List 1 or List 2 (n-back), whereas another group only looked for changes from within List 2 (within-list back). List 1 recall for between-list A–B, A–C pairs showed retroactive facilitation for the n-back group but did not differ from control pairs for the Within-list back group. These results suggested that directed remindings of List 1 pairs during List 2 study enhanced List 1 recall through retrieval practice. However, the effects of recollecting remindings could not be assessed because the final test did not include a measure of that sort.

To address this limitation, Negley et al. (2018) examined the effects of List 1 remindings during List 2 in a paradigm that included a measure of reminding recollection at test. Reminding recollection was assumed to occur when participants could both successfully indicate that a pair had changed and correctly recall the List 2 response. By also including a manipulation of List 2 study time, the authors tested the idea that more time spent with competing information can lead to better memory. Although classic interference theories predict that more exposure to competing information should further impair retrieval of earlier memories (e.g., McGeoch, 1932), the MFC framework predicts that more exposure to competing information with shared features could allow for more remindings and therefore improve retrieval of earlier memories. Consistent with this prediction, longer List 2 study time was associated with more remindings and enhanced List 1 recall compared with shorter List 2 study time. In addition, retroactive facilitation was observed when remindings occurred during List 2, regardless of whether remindings were later recollected at test. Important for the MFC framework, reminding recollection was associated with higher List 1 recall than when List 1 recall was conditionalized on remindings alone. These results suggest that retrieval practice during List 2 benefitted later memory and that recollection-based retrieval of configural representations conferred an additional benefit to List 1 recall.

The two studies of retroactive effects of memory above suggest that manipulations that increase opportunities for integrative encoding in A–B, A–C paradigms can alleviate retroactive interference. Those studies also suggest that when people are reminded less often, they are more susceptible to retroactive interference. Accordingly, the MFC framework predicts that older adults should experience greater retroactive interference than younger adults to the extent that older adults' recollection deficit (for reviews, see Balota, Dolan, & Duchek, 2000; Zacks, Hasher, & Li, 2000) reduces the frequency of remindings and later recollection of remindings. In the present study, we tested the hypothesis that older adults would experience greater retroactive interference than younger adults because older adults would be reminded of List 1 responses less often during List 2 and recollect fewer remindings at test.

Experiment 1

In Experiment 1, we characterized retroactive effects of memory in older and younger adults in a variant of an A–B, A–C paradigm with instructions that encouraged integrative encoding during List 2. This allowed us to test predictions from the MFC framework about the role of remindings in such effects. To examine these effects, we attempted to manipulate the frequency of remindings during List 2 by varying List 2 study times within subjects, which replicated the approach from Negley et al. (2018). This manipulation also allowed us to determine whether longer List 2 study times would confer differential benefits for older and younger adults. We tested the hypothesis that longer List 2 study durations would provide more opportunities for remindings, particularly for older adults because they are generally assumed to process information more slowly (e.g., Salthouse, 1996). We assessed potential variations in the frequencies of remindings indirectly using a reminding recollection measure at test.

Method

In both experiments, we report how we determined sample sizes, all data exclusions, all manipulations, and all measures (Simmons, Nelson, & Simonsohn, 2012). The stimuli, data, and analysis scripts are available at https://osf.io/z78fc/. The research reported here was approved by the Institutional Review Board at The University of North Carolina at Greensboro (UNCG).

Participants. We tested 48 younger adults (34 women, 14 men), ages 18–23 (M = 19.25, SD = 1.42), from UNCG, and 36 older adults (25 women, 11 men), ages 60 to 75 (M = 68.75, SD = 3.95), from Greensboro and the surrounding areas. For compensation, younger adults received course credit, and older adults received $10 per hr. We screened for cognitively healthy older adults by administering the Short Blessed Test (SBT; Katzman et al., 1983) over the phone and the Mini Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975) in person. The inclusion criteria were as follows: an SBT weighted error score ≤4, an MMSE score ≥25, and no reported recent neurological event (e.g., a stroke).[1] All older adults had a visual acuity score ≥20/50 on the Snellen Eye Test (Hetherington, 1954). Table 1 displays all cognitive ability scores.

We chose the sample sizes here based on prior work and available resources (i.e., time and money). We oversampled younger adults to increase power; we doubled the sample size of younger adults and chose a 50% larger sample of older adults relative to Wahlheim (2014, Experiment 3), from which the current materials were taken. According to G*Power Version 3.1.9.2. (Faul, Erdfelder, Buchner, & Lang, 2009), with N = 84, we had 80% power (α = .05, two-tailed) to detect a medium effect size (η_p^2 = .089).

Design. We used a 2 (age: younger vs. older) × 3 (item type: A–B, A–B vs. A–B vs. A–B, A–C) × 2 (study time: 2 s vs. 10 s) mixed design. Age was treated as a between-participants factor, whereas Item Type and Study Time were manipulated within participants.

Materials. The materials, taken from Wahlheim (2014), consisted of 96 three-word sets comprised of one cue (e.g., ball) and two responses (e.g., bounce, park). According to the Nelson, McEvoy, and Schreiber (1998) free association norms, the forward and backward association strengths between cues and responses were comparably low ([forward: M = .04, SD = .02, range = .01–.10] vs. backward: [M = .021, SD = .031, range = .00–.10]). The responses in each set were not associated, which minimized the possibility that reminding effects could be completely explained by spreading activation between responses.

Of the 96 sets, 90 served as critical items, and six served as buffers against primacy and recency effects. We divided the critical items into six groups of 15 items that were each matched on word frequency according to hyperspace analog to language

[1] We replaced three older adults for the following reasons: After the experimental session, one person reported having recently experienced a stroke; we discovered that one person who scored above the cutoff on the SBT error measure was invited to participate due to a response coding error; and one person scored below the MMSE cutoff.

Table 1
Performance and Demographic Measures for Younger and Older Adults: Experiments 1 and 2

		Age			
		Younger		Older	
Experiment	Task	*M* (*SD*)	Range	*M* (*SD*)	Range
Experiment 1	Vocabulary (out of 40)	27.18 (4.27)	19–37	35.50 (2.90)	30–40
	Education (years)	13.13 (1.26)	12–16	16.02 (1.99)	12–19
	SBT (error score)			0.61 (1.02)	0–4
	MMSE			28.14 (1.46)	25–30
Experiment 2	Vocabulary (out of 40)	27.23 (4.70)	11–37	35.06 (3.13)	27–39
	Education (years)	12.96 (1.07)	12–16	16.44 (2.24)	12–19
	SBT (error score)			0.58 (1.02)	0–4
	MMSE			28.25 (1.13)	26–30
	DSST (in 90 s)			51.61 (9.84)	27–71
	DSST (out of nine)			6.00 (2.31)	1–9

Note. Vocabulary = Shipley Institute of Living Scale vocabulary (Shipley, 1986); SBT = Short Blessed Test; MMSE = Mini Mental State Exam (Folstein, Folstein, & McHugh, 1975); Education = self-reported years of education; DSST = digit symbol substitution task (Wechsler, 1981).

(HAL) log frequency counts (Lund & Burgess, 1996) taken from the English Lexicon Project database (Balota et al., 2007). The values for each group ranged from 5.73 to 12.67 ($M = 9.60$, $SD = 1.48$). Groups were also matched on word length ($M = 5.30$, $SD = 1.22$, range = 4–8).

The experiment included the following phases: List 1, List 2, practice test, and actual test. List 1 contained 90 critical and six buffer items. Thirty critical items appeared in each of the item type conditions, and one buffer item appeared in each combination of item type and list position (i.e., primacy and recency) conditions. List 2 contained 60 critical pairs and four buffer items. Thirty pairs appeared in each of the A–B, A–B, and A–B, A–C conditions (control pairs were not included in List 2), and one buffer item appeared in each combination of item type and list position conditions. In both lists, the 30 critical pairs in each item type condition were divided into two groups of 15 pairs corresponding to each of the study time conditions. Note that this distinction was arbitrary for A–B control items in List 1 because those items were not subjected to the study time manipulation. For counterbalancing, we rotated critical item sets across within-subject conditions, producing six experimental formats. The assignment of buffer items to conditions remained constant across formats. The practice test phase contained cues from the six buffer pairs that appeared in List 1. The actual test phase contained cues from the 90 critical pairs that appeared in List 1.

Procedure. All participants were tested individually. The stimuli were presented on computers using E-Prime 2 software (Psychology Software Tools, Pittsburgh, PA). In all phases of the experiment, stimuli appeared in a white font against a black background.

In List 1, pairs appeared for 8 s each followed by a 500-ms interstimulus interval (ISI). Primacy and recency buffers appeared in the first and last three positions of the list, respectively. Participants were asked to read the pairs aloud and study them for an upcoming test. In List 2, pairs appeared for either 2 s or 10 s each followed by a 500-ms ISI. Participants were told that some pairs would appear for longer than others. They were further told that some pairs would be the same as in List 1, whereas others would include the same cue paired with a changed response. Finally, they were told that noticing the changed pairs could help them on the memory test. In both lists, pairs appeared in a fixed random order, with the constraint that items from the same condition did not appear consecutively more than three times. The average list position was equated across conditions to control for serial position effects.

On both the practice and actual tests, cues appeared one at a time next to a question mark (e.g., ball- ?). Participants were instructed to first attempt to recall the response that was paired with the cue in List 1. After typing their response, participants indicated whether that response changed between lists by clicking on boxes labeled "Yes" or "No" that were shown below the cue. When participants selected "Yes," they were prompted to type in the changed response that appeared in List 2. When participants selected "No," the next test cue appeared. Cues remained on the screen until participants responded. Cues appeared in a fixed random order, with the constraint that items from the same condition did not appear more than three times consecutively. The average serial position was equated across conditions to control for serial position effects and to equate lags between study and test items in each condition.

Finally, all participants completed a computerized Shipley Vocabulary test (Shipley, 1986). Older adults then completed the MMSE (Folstein et al., 1975).

Results

We performed all statistical tests using R software (R Development Core Team, 2008). We modeled the effects of experimental manipulations using linear and logistic mixed effects models, fit with functions from the lme4 package (Bates, Mächler, Bolker, & Walker, 2014). We performed hypothesis tests using the anova function of the car package (Fox & Weisburg, 2011) and post hoc comparisons using the Tukey method in the emmeans package (Lenth, 2018). In both experiments, we treated experimental factors as fixed effects, and Subjects and Items as random effects. Importantly, this allowed us to examine whether performance differences revealed by conditional analyses remained while controlling for variability due to participants and items. The level for significance was $\alpha = .05$.

List 1 recall. To examine whether age and study time interacted with retroactive effects of memory, we first analyzed overall List 1 recall (Figure 1; black points). Note that in the following analyses we treated A–B control item subgroups as separate cells based on the arbitrary study time labels from the counterbalance scheme. List 1 recall did not differ across the arbitrary cells for either age group, largest $z = 1.44$, $p = .15$, indicating that these cells could be included in pairwise comparisons to evaluate retroactive effects of memory in our subsequent models. We examined List 1 recall using an Age × Item Type × Study Time model. The model indicated a significant effect of Item Type, $\chi^2(2) = 431.46$, $p < .001$, showing that List 1 recall was significantly higher for A–B, A–B items than the other two item types, smallest $z = 17.26$, $p < .001$, and did not differ between A–B and A–B, A–C items, $z = 1.75$, $p = .19$. No other effects were significant, largest $\chi^2(2) = 4.48$, $p = .11$. These results showed that retroactive effects of memory were comparable across age groups and study time conditions.

List 2 intrusions onto List 1 recall. We further examined whether age and study time interacted with retroactive effects of memory by analyzing the rates of List 2 intrusions onto List 1 recall (see Table 2, top rows). Note that intrusions for A–B, A–B and A–B control items are baseline estimates of guessing the alternative response during List 1 recall that would have appeared in List 2 had those items been assigned to the A–B, A–C condition. The baseline rates were comparably low in all cells ($M \leq .02$), so we do not include them in the following analysis. An Age × Study Time model fitted to A–B, A-C items indicated a significant effect of Age, $\chi^2(1) = 5.18$, $p = .02$, showing higher List 2 intrusions onto List 1 recall for younger than older adults. No other effects were significant, largest $\chi^2(1) = 1.93$, $p = .17$. These findings showed that younger adults made more source monitoring errors than older adults.

Change classifications. To examine the role of remindings in retroactive effects of memory described above (inferred here from rates of reminding recollection at test), we first computed probabilities for three categories of change classification for A–B, A–C items (see Table 3). *Recollect reminding* refers to instances when

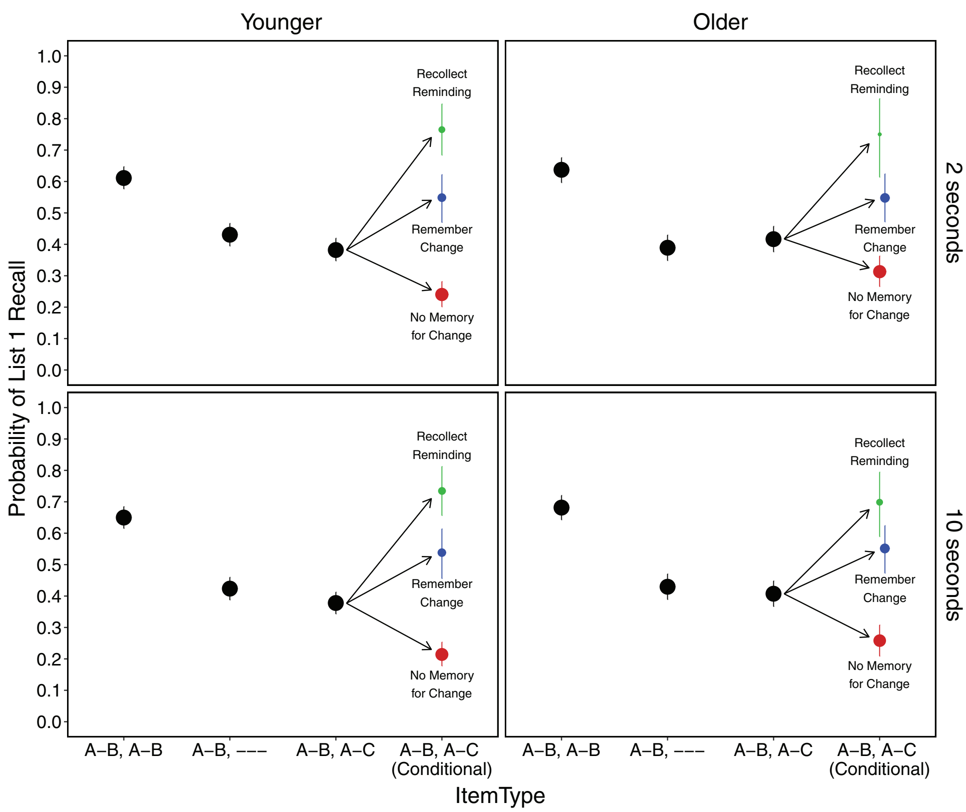

Figure 1. Probabilities of correct List 1 recall as a function of age, item type, and study time in Experiment 1. The areas of the conditional points (in green [light gray], blue [dark gray], and red [medium gray]) for A–B, A–C items correspond to the proportions of responses on the cued recall test that were included in each of the three conditions. The green (light gray) points indicate when change was classified and the List 2 response was reported at test (Recollect Reminding), and the blue (dark gray) points indicate when change was classified but the List 2 response was not reported at test (Remember Change). The red (medium gray) points indicate when change was not classified at test (No Memory for Change). The heights of the conditional points indicate the probability of correct List 1 recall for those subsets of items. Error bars are bootstrap 95% confidence intervals. See the online article for the color version of this figure.

Table 2
List 2 Intrusions Onto List 1 Recall for A–B, A–C Items as a Function of Age and Study Time: Experiments 1 and 2

Experiment	Age	Study time 2 s	Study time 10 s
Experiment 1	Younger	.15 [.12, .18]	.18 [.15, .21]
	Older	.13 [.10, .16]	.12 [.10, .15]
Experiment 2	Younger		.19 [.17, .22]
	Older		.13 [.11, .16]

Note. Bootstrap 95% confidence intervals are displayed in brackets. Baselines intrusion estimates for A–B, A–B, and A–B conditions were ≤ .02 in all cells.

items were classified as changed and List 2 responses were correctly recalled. *Remember change* refers to instances when items were classified as changed and List 2 responses were not correctly recalled. These two response categories were computed as joint probabilities. The model for no memory for change refers to instances when items were not classified as changed. Note that the MFC framework makes clear predictions about how recall performance should be associated with reminding recollection and the absence of memory for change. However, theoretical and empirical work is currently underway to establish the processes involved when changes are remembered but not recollected, and the associated effects on recall performance. Consequently, we treat all analyses including those cells as exploratory.

To simplify comparisons of age differences across response categories, we fitted separate Age × Study Time models to each category. The model for recollect reminding responses indicated a significant effect of Study Time, $\chi^2(1) = 14.68$, $p < .001$, showing that more remindings were recollected when study time was longer compared to when it was shorter. No other effects were significant, largest $\chi^2(1) = 2.20$, $p = .14$. The model for remember change responses indicated a significant effect of Age, $\chi^2(1) = 4.53$, $p = .03$, showing that more changes were remembered without remindings being recollected by older than younger adults. No other effects were significant, largest $\chi^2(1) = 0.45$, $p = .50$. The model for no MFC responses indicated a significant effect of Study Time, $\chi^2(1) = 7.79$, $p = .005$, showing that changes were remembered less often when study time was shorter compared to when it was longer. No other effects were significant, largest $\chi^2(1) = 0.97$, $p = .32$. Together these results showed that longer study time benefitted reminding recollection, and that older adults were more likely to indicate change at test without being able to recall the List 2 response.

List 1 recall conditionalized on change classification. To examine the associations between reminding recollection and List 1 recall, we examined probabilities of List 1 recall conditionalized on change classifications made for A–B, A–C items (see Figure 1, green [light gray], red [medium gray], and blue [dark gray] points). We performed conditional analyses of List 1 recall using an Age × Item Type × Study Time model. The Item Type factor included four levels: the three levels of change classification for A–B, A–C items described in the preceding text, and A–B control items. A–B control items were included to assess variations in retroactive effects of memory across A–B, A–C conditions. We do not report main effects that are the same as those of previous analyses.

The model indicated a significant effect of Item Type, $\chi^2(3) = 178.36$, $p < .001$, and a significant Age × Item Type interaction, $\chi^2(3) = 9.00$, $p = .03$. Regarding retroactive effects of memory, List 1 recall was significantly higher for recollect reminding and remember change than for A-B control items for both age groups, smallest $z = 4.50$, $p < .001$, indicating retroactive facilitation for items in which remindings were recollected or were identified as changed at test. Conversely, List 1 recall was significantly lower for no memory for change compared with A–B control items for both age groups ($z = 8.23$, $p < .001$), indicating retroactive interference for items that were not identified as changed at test. These results showed that both age groups experienced retroactive facilitation when changes were remembered or remindings were recollected, and retroactive interference when changes were not remembered. The interaction showed that, for younger adults, List 1 recall was significantly higher for recollect reminding than for remember change ($z = 2.87$, $p = .02$). In contrast, for older adults, List 1 recall did not differ between recollect reminding and remember change ($z = 2.07$, $p = .16$). These results show a qualitative age difference in recall patterns: Older adult showed comparable List 1 recall benefits when remindings were recollected and changes were remembered at test, whereas younger adults showed significantly higher recall when remindings were recollected than when changes were remembered at test. No other effects were significant (largest $\chi^2 = 3.16$, $p = .37$).

Discussion

The results from Experiment 1 showed comparable List 1 recall for both age groups and more List 2 intrusions onto List 1 recall for younger than older adults. Contrary to most of the prior cognitive aging research, these results suggest that source monitoring errors were greater for younger than older adults. In addition, both age groups recollected remindings more often when List 2 pairs appeared for a longer rather than a shorter length of study time.

Table 3
Change Classification Probabilities for A–B, A–C Items as a Function of Age, Classification Type, and List 2 Study Time: Experiment 1

Age	Recollect reminding 2 s	Recollect reminding 10 s	Remember change 2 s	Remember change 10 s	No memory for change 2 s	No memory for change 10 s
Younger	.14 [.11, .16]	.18 [.15, .21]	.23 [.20, .26]	.22 [.19, .25]	.63 [.60, .67]	.60 [.57, .64]
Older	.08 [.06, .11]	.14 [.11, .16]	.29 [.25, .33]	.30 [.27, .34]	.63 [.59, .67]	.56 [.52, .60]

Note. Bootstrap 95% confidence intervals are displayed in brackets.

However, this did not lead to age differences in overall List 1 recall for A–B, A–C items due to the balance of recall probabilities across conditional cells. Importantly, the analyses of change classifications showed that older adults were more likely than younger adults to remember changes without recollecting remindings. This age difference suggests that older adults had less precise memory for changes, which is consistent with the idea that older adults experience a recollection deficit. Consistent with the MFC framework, both age groups showed retroactive facilitation in List 1 recall for A–B A–C items when they recollected remindings and retroactive interference when they did not remember change. However, younger adults showed greater retroactive facilitation when they recollected remindings than when they remembered changes, whereas older adults showed comparable performance in both instances. To further investigate remindings and their association with List 1 recall, we included a direct measure of remindings in Experiment 2.

Experiment 2

In Experiment 2, we attempted to replicate the patterns of overall memory performance from Experiment 1 and included a direct measure of remindings as they occurred in List 2. This allowed us to more completely characterize the association between remindings and later recall performance. The MFC framework predicts that remindings in List 2 will enhance List 1 recall for both age groups, but older adults' recollection deficit should lead to fewer remindings and recollection of remindings. Consequently, older adults should receive fewer of the List 1 recall benefits that are associated with remindings and their recollection. We chose not to manipulate study time here to provide more observations for analyses of List 1 recall conditionalized on remindings during List 2 and later memory for remindings at test.

Method

Participants. We tested 48 younger adults (32 female, 16 male), ages 18 to 26 (M = 19.17, SD = 1.37), from UNCG, and 36 older adults (24 female, 12 male), ages 60 to 75 (M = 68, SD = 4.17), from Greensboro and the surrounding areas. The compensation, eligibility requirements, and sample size justification were the same as in Experiment 1. Table 1 displays demographic information and cognitive ability scores.

Design. We used a 2 (age: younger vs. older) × 3 (item type: A–B, A–B vs. A–B vs. A–B, A–C) mixed design. Age was treated as a between-participants variable, and Item Type was manipulated within participants.

Materials. We reduced the overall number of items from Experiment 1 by selecting the 60 critical sets that produced the highest List 1 recall performance. Doing so allowed the experiment to be completed in one hour. The average association strengths between responses, word lengths, and word frequencies were comparable to the larger set. List 1 contained 60 critical items, and List 2 contained 40 critical items (20 per condition). The counterbalancing scheme and buffer items were the same as in Experiment 1.

Procedure. The procedure for Experiment 2 followed that of Experiment 1, with the following modifications. List 2 pairs appeared for 10 s each. During List 2, participants were instructed to press the *1* key when they detected changed pairs, and to study the pair until it disappeared after detecting the change. To measure remindings, a screen appeared after the 10-s study time had elapsed that asked participants to report the List 1 response. An experimenter recorded those responses, and participants pressed the spacebar to move onto the next study pair. If participants did not detect a change, they were told to study the pair until it disappeared from the screen. We modified the response mapping for change classifications on the cued-recall test because some older adults from Experiment 1 had difficulty alternating between the mouse and keyboard. Participants indicated that pairs had changed by pressing the *1* key and that pairs had not changed by pressing the *0* key. After the experiment, older adults completed the MMSE (Folstein et al., 1975) and then the digit symbol substitution task (DSST), which was taken from the Wechsler Adult Intelligence Scale–Revised (Wechsler, 1981).

Results

List 1 recall. We first assessed overall List 1 recall performance (see Figure 2, black points) using an Age × Item Type model. The model indicated a significant effect of Item Type, $\chi^2(2) = 446.32$, $p < .001$, showing that recall was higher for A–B, A–B than both A–B and A–B, A–C items (smallest $z = 19.02$, $p < .001$) and did not differ between A–B and A–B, A–C items ($z = .12$, $p = .99$). Neither the effect of Age, $\chi^2(1) = 3.67$, $p = .055$, nor the Age × Item Type interaction was significant, $\chi^2(2) = 2.03$, $p = .36$. These results showed that correct recall for List 1 did not differ significantly for older and younger adults.

List 2 intrusions onto List 1 recall. We compared the rates of List 2 intrusions onto List 1 recall between age groups (see Table 2, bottom rows). Baseline intrusion rates for A–B, A–B, and A–B control items were comparably low for both age groups ($M \leq .02$). The model including only intrusions for A–B, A–C items indicated a significant effect of Age, $\chi^2(1) = 4.35$, $p = .04$, showing more intrusions for younger than older adults. Replicating Experiment 1, these results showed more source monitoring errors for younger than older adults in the form of List 2 intrusions onto List 1 recall.

Change classifications. We examined age differences in memory for change both during List 2 and at test. We first examined each measure separately to characterize potential age differences in List 2 responses and to provide a direct comparison of change classification responses at test with those reported in Experiment 1. We then combined these measures to establish how change classifications made during List 2 translated in change classifications made at test. The analyses combining measures from List 2 and test were important for understanding how overall recall patterns were achieved when interpreting later conditional analyses of recall performance.

List 2. We computed probabilities for three categories of change classification for A–B, A–C items during List 2 (see Table 4, top rows). *Reminding* refers to instances when items were classified as changed and List 1 responses were correctly recalled. *Notice change* refers to instances when items were classified as changed and List 1 responses were not recalled. These response categories were computed as joint probabilities. *No change* refers to instances when items were not classified as changed.

To simplify comparisons of age differences across response categories, we fitted separate models with Age as the factor to each

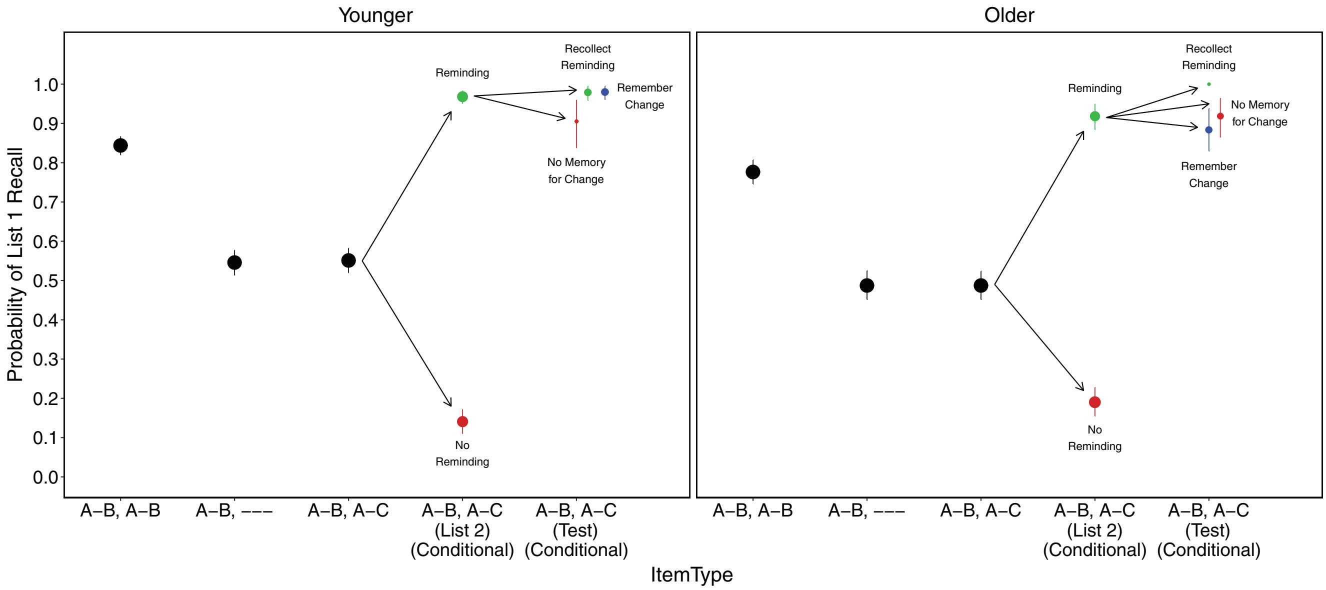

Figure 2. Probabilities of correct List 1 recall as a function of age and item type in Experiment 2. The areas of the conditional points (in green [light gray], blue [dark gray], and red [medium gray]) for A–B, A–C items correspond to the proportion of responses on the cued recall test that were included in each condition. For the points above A–B, A–C (List 2) (conditional), green (light gray) indicates when a reminding occurred for participants while the red (medium gray) indicates when participants were not reminded. The green (light gray) and blue (dark gray) points above A–B, A–C (Test) (conditional) indicate when change was classified and the List 2 response was recalled at test (Recollect Reminding), and when change was classified but the List 2 response was not recalled at test (Remember Change), respectively. The corresponding red dot indicates when change was not classified at test (No Memory for Change). The heights of the conditional points indicate the probability of correct List 1 recall for those subsets of items. Error bars are bootstrap 95% confidence intervals. See the online article for the color version of this figure.

classification type. The model for reminding responses indicated no significant effect, $\chi^2(1) = 3.59$, $p = .058$. The model for notice change responses indicated a significant effect, $\chi^2(1) = 29.26$, $p < .001$, showing that older adults detected changes without recalling List 1 responses more often than younger adults. The model for no change indicated no significant effect, $\chi^2(1) = 3.29$, $p = .069$. Finally, we also examined false alarm rates for A–B, A–B items classified as changed. The rates were comparably low for both younger ($M = .02$, 95% CI [.01, .03]) and older ($M = .05$, 95% CI [.03, .06]) adults, $\chi^2(1) = 0.00$, $p = .99$. These results show that older adults made change classifications on the basis of memory for List 1 responses less often than younger adults. This age difference in List 1 recall presumably reflects older adults' deficit in recollection.

Table 4
Change Classification Probabilities for A-B, A-C Items as a Function of Age and Classification Type During the List 2 and Test Phases: Experiment 2

Phase	Age	Reminding	No reminding: Notice change	No reminding: No change
List 2	Younger	.49 [.45, .52]	.13 [.11, .16]	.38 [.35, .41]
	Older	.41 [.37, .44]	.30 [.27, .33]	.29 [.26, .32]
Phase	**Age**	**Recollect reminding**	**Reminding not recollected: Remember change**	**Reminding not recollected: No memory for change**
Test	Younger	.26 [.23, .29]	.27 [.25, .30]	.47 [.44, .50]
	Older	.12 [.10, .15]	.30 [.27, .34]	.58 [.54, .61]

Note. Bootstrap 95% confidence intervals are displayed in brackets.

Test. We analyzed the same three categories of change classification at test as in Experiment 1 (see Table 4, bottom rows). The model for recollect reminding responses indicated a significant effect, $\chi^2(1) = 13.30$, $p < .001$, showing that younger adults recollected more remindings than older adults. The model for remember change responses indicated no significant effect, $\chi^2(1) = 0.54$, $p = .46$. The model for no memory for change responses also indicated no significant effect, $\chi^2(1) = 3.31$, $p = .07$. Finally, there was no difference in false alarm rates between older and younger adults for the A–B, A–B items (older: $M = .04$, 95% CI [.02, .06]; younger: $M = .02$, 95% CI [.01, .03], $\chi^2(1) = 3.74$, $p = .053$), but there was a significant difference for A–B control items (older: $M = .05$, 95% CI [.03, .09]; younger: $M = .02$, 95% CI [.01, .03], $\chi^2(1) = 9.55$, $p = .002$). These results suggest that younger adults were better able to recollect List 2 changes and show that older adults were more biased to classify control items as changed.

List 2 and test. The combined measures of change classification from List 2 and test are displayed in Table 5. As in the analyses above, we fitted separate models with Age as the factor to

Table 5
Change Classification Probabilities for A–B, A–C Items as a Function of Age and Classification Type for Combinations of List 2 and Test Phases: Experiment 2

Age	Reminding + Recollect Reminding	Reminding + Remember Change	Reminding + No Memory for Change	No reminding
Younger	.20 [.18, .23]	.21 [.19, .24]	.08 [.06, .09]	.51 [.48, .54]
Older	.08 [.06, .09]	.18 [.15, .21]	.15 [.13, .18]	.59 [.56, .63]

Note. Bootstrap 95% confidence intervals are displayed in brackets.

each classification type. The model for Reminding + Recollect Reminding responses indicated a significant effect, $\chi^2(1) = 16.71$, $p < .001$, showing a higher rate of being reminded in List 2 and recollecting reminding at test for younger than older adults. The model for Reminding + Remember Change responses indicated no significant effect, $\chi^2(1) = 1.96$, $p = .16$. The model for Reminding + No Memory for Change responses indicated a significant effect, $\chi^2(1) = 9.02$, $p = .003$, showing a higher rate of being reminded in List 2 and not indicating change at test for older than younger adults. These combinations of List 2 and test measures confirmed that older adults were less likely to recollect remindings that occurred in List 2.

List 1 recall conditionalized on change classifications. In the final set of analyses, we examined List 1 recall conditionalized on whether participants were reminded during List 2 and on the three categories of change classification at test (see Figure 2: green [light gray], red [medium gray], and blue [dark gray] points) in order to investigate the associations of remindings and later reminding recollection with List 1 recall. For the absence of remindings during List 2, we created a "no reminding" response category that collapsed across the notice-change and no-change categories.

Reminding in List 2. We fitted a model to conditional List 1 recall with Age and Item Type (A–B, A–C [reminding] vs. A–B, A–C [no reminding] vs. A–B) as factors. The model indicated a significant effect of Item Type, $\chi^2(2) = 544.04$, $p < .001$, showing that List 1 recall for A–B, A–C items was higher when remindings occurred in List 2 than when they did not. There was no significant effect of Age, $\chi^2(1) = 1.69$, $p = .19$, but there was a significant Age × Item Type interaction, $\chi^2(2) = 12.93$, $p = .002$. When remindings occurred, List 1 recall was significantly greater for younger than older adults ($z = 2.84$, $p = .005$). However, when remindings did not occur, List 1 recall did not differ between age groups ($z = 1.13$, $p = .26$). Regarding retroactive effects of memory, retroactive facilitation was observed when remindings occurred, as reminded items were recalled more often than control items ($z = 15.52$, $p < .001$), and retroactive interference was observed when remindings did not occur, as nonreminded items were recalled less often than control items ($z = 15.68$, $p < .001$). These results show that retrieval of List 1 responses during List 2 was associated with retroactive facilitation, and that older adults showed an episodic memory deficit for List 1 responses at test even when they were successfully reminded of those responses during List 2.

Reminding in List 2 and reminding recollection at test. We conditionalized List 1 recall of A–B, A–C items for which remindings occurred during List 2 on change classifications at test. We fitted an Age × Classification model to A–B, A–C items for the three levels of change classification at test (i.e., recollect reminding, remember change, and no memory for change).

The model indicated no significant effect of Age, $\chi^2(1) = 3.53$, $p = .06$, no significant effect of Classification, $\chi^2(2) = 2.60$, $p = .27$, and a significant Age × Classification interaction, $\chi^2(2) = 6.98$, $p = .03$. The interaction showed that for younger adults, List 1 recall was significantly higher for both recollect reminding and remember change than for no memory for change (smallest $z = 2.39$, $p = .045$), and List 1 recall did not differ between recollect reminding and remember change ($z = 0.10$, $p = .99$). For older adults, there were no significant differences among conditional cells (largest $z = 1.02$, $p = .56$). This lack of an effect for older adults could partly reflect the low number of observations in the reminding recollection cell for older adults. Despite this lack of differences, it is noteworthy that List 1 recall was perfect for all items for which remindings were recollected. Taken together, these results are consistent with the MFC framework in showing that reminding recollection was associated with benefits above reminding without memory for change. These results also suggest that older adults can benefit from reminding recollection, but they do so less often than younger adults.

Discussion

Consistent with Experiment 1, there was no age-related difference in retroactive effects of memory in overall List 1 recall, but younger adults made more source monitoring errors, as they produced more List 2 intrusions onto List 1 recall than older adults. During List 2, older adults were more likely to notice change without recall of List 1. At test, older adults were less likely to recollect remindings and were more likely to indicate changes for control items than younger adults. These results suggest that older adults relied on recollection as a basis for change classifications in both List 2 and at test less than younger adults. The benefits of reminding for List 1 recall were greater for younger than older adults, which suggests that retrieval practice led to more durable List 1 representations for younger adults. Consistent with the MFC framework, conditional List 1 recall showed that remindings led to retroactive facilitation and the absence of remindings led to retroactive interference. There was also an additional benefit from recollecting such remindings that appeared for younger but not older adults. However, the low number of observations in the reminding recollection cell for older adults likely precluded our ability to detect such benefits in the statistical analyses. Overall, these results are generally consistent with predictions from the MFC framework, as remindings that allowed for integrative encoding were associated with enhanced memory performance for List 1 to varying degrees for older and younger adults.

General Discussion

The primary goal of the present study was to examine the role of reminding in retroactive effects of memory for older and younger adults using variants of an A–B, A–C paradigm. We found that older and younger adults showed comparable overall List 1 recall in both experiments. Younger adults showed higher List 2 recall after indicating change at test and more List 2 intrusions onto List 1 recall than older adults in both experiments. Older adults were more likely to notice changes without recalling List 1 responses during List 2 and recollected fewer remindings at test than younger adults. Critically, remindings were associated with higher List 1 recall at test for younger than older adults. Recollection of remindings at test were also more clearly associated with an additional benefit to List 1 recall for younger than older adults. These results are generally in line with predictions from MFC in showing critical roles for reminding and reminding recollection in age differences in retroactive effects of memory. In what follows, we consider the theoretical implications of the present findings.

Theoretical Implications for Age Differences in Episodic Memory

It has previously been shown that in A–B, A–C paired associate paradigms, older adults experience greater susceptibility to retroactive interference than younger adults (e.g., Arenberg, 1967; Traxler, 1973). As discussed in the Introduction, it has long been assumed that using A–B, A–C paradigms to examine memory under conditions of retroactive interference adequately measures age differences in inhibition abilities (e.g., Kane & Hasher, 1995). However, the present results clearly show that one need not propose a role for inhibitory processing to explain the age differences in retroactive effects of memory found in prior work. Instead, the MFC framework proposes that older adults experience age-related recollection deficits that reduce the ability to recall List 1 responses during List 2 (a reminding) and to later recollect such experiences. The framework further assumes that remindings increase the accessibility of List 1 responses through retrieval practice and enable the encoding of responses from both lists and the associated temporal order in which they occurred. Consequently, the framework predicts that older adults should experience fewer memorial benefits of reminding and reminding recollection than younger adults in retroactive experimental conditions. Consistent with this, we found that older adults were more likely to indicate change without recall of the List 1 response during List 2 than younger adults (i.e., older adults experienced fewer remindings). At test, older adults were less likely to recollect remindings, and were more likely to remember changes without correct recall of the List 2 response. Furthermore, older adults showed lower conditionalized List 1 recall than younger adults even when they experienced remindings.

Although the present findings fit with predictions from MFC, it is noteworthy that older adults were not more susceptible to retroactive interference in overall performance. This lack of effect may seem surprising given that several extant theories predict that older adults should be less able to differentiate between competing sources of information. As mentioned in the introductory text, inhibition deficit theory posits that older adults are less effective at suppressing distracting or irrelevant information in memory, which causes them to experience greater response competition when attempting to recall target information (e.g., Hasher & Zacks, 1988; Lustig et al., 2007). In addition, dual process theories of age differences in episodic memory assume that older adults experience a selective deficit in controlled retrieval processes, which explains why older adults have poorer memory for temporal contextual features that are associated with a response (for a review, see Koen & Yonelinas, 2014). Similarly, source memory accounts of age-related episodic memory deficits also claim that older adults experience impairments in memory for contextual information, as shown by poorer memory for the features associated with items than for the items themselves (for a review, see Dodson, 2017).

This incompatibility between the present results and these prominent theories further highlights the utility of the MFC framework for explaining age-related memory differences under retroactive experimental conditions. The feature of this framework that allows it to accommodate the present results is that it assumes that overall recall performance is comprised of a balance of facilitation and interference effects that is determined by the extent to which remindings occur and are later recollected. This framework could explain the lack of age differences in the susceptibility of retroactive interference by assuming age differences in encoding efficacy in List 2. Older adults may have encoded List 2 study items less effectively than younger adults, either because older adults experienced greater proactive interference (cf. Wahlheim, 2014) and/or because they strategically prioritized attention to List 1. In either case, List 2 pairs would be less competitive at retrieval for older than younger adults, which would reduce the need for recollection to retrieve List 1 responses. This may also explain why younger adults experienced greater List 2 intrusions onto List 1 recall. If younger adults processed List 2 more effectively than older adults, then it would be a stronger competitor when asked to recall List 1. Further empirical work is needed to test the viability of this proposal.

There are also methodological differences between the present and earlier experiments that could help explain why older adults were not more susceptible to retroactive interference in overall performance here. First, the materials used in the current study are different from previous experiments examining age differences in retroactive interference. In the current study, cues and responses within word pairs were semantically associated, while Traxler (1973), whose results showed greater retroactive interference for older adults, used unrelated word pairs. Given that older adults show greater episodic memory deficits in cued recall when word pairs are unrelated (e.g., Naveh-Benjamin, 2000, Experiment 4), the inclusion of semantically associated word pairs in the current study could have made those pairs memorable enough for older adults to eliminate retroactive interference through reminding or some other mechanism. Second, Traxler (1973) intermixed study and test trials, which could have encouraged participants to encode each list in isolation. Further, between-list retrievals occurred at short lags and this could have limited the potential benefits of remindings on later recall. In contrast, in the present experiments, we encouraged participants to retrieve from List 1 during List 2, and such retrievals occurred at much longer lags. Based on the findings from Jacoby et al. (2015) showing that List 1 recall for A–B, A–C items was greater when remindings occurred at longer compared to shorter lags, we believe that the experimental conditions of including changes at longer lags between lists optimized the benefits of remindings on later List 1 recall for both age groups.

Although we found clear evidence for the role of reminding in age differences in retroactive effects of memory, one limitation to the study is that younger and older adults showed comparable List 1 recall. The lack of age differences in recall is inconsistent with most aging studies included in the literature, as cued recall performance is typically lower for older than younger adults (e.g., Craik & McDowd, 1987). Although this creates a minor complication for interpretation, it was more important that we found age differences in conditional analyses of List 1 recall when original learning was equated between age groups. Therefore, we argue that these experiments provide important information for theories of age-related memory differences. To improve the precision of interpretation in future experiments, it could be worthwhile to characterize our samples using a broader battery of standardized cognitive ability measures. This would allow us to examine the extent to which younger and older adults in our samples are representative of a larger group of people who were also tested on those measures.

Implications for the MFC Framework

The MFC framework was originally proposed to explain proactive effects of memory (Jacoby et al., 2013; Wahlheim & Jacoby, 2013). Along with two recent studies (Jacoby et al., 2015; Negley et al., 2018), the present study extends MFC to explain how remindings and recollection of remindings can influence earlier memories under conditions of retroactive interference. In addition, one goal of Experiment 1 was to replicate the List 2 study time effects on remindings, and later List 1 recall shown by Negley et al. (2018). Classic interference theories predict that more exposure to List 2 items should increase retroactive interference, thus further impairing List 1 recall. However, MFC predicts that more exposure to List 2 items should increase the opportunity for remindings. Consistent with this, Negley et al. (2018) showed that longer List 2 study times (7 s vs. 1 s) were associated with higher List 1 recall, which was driven by higher rates of reminding and recollection of remindings.

We replicated the study time effect on reminding recollection in Experiment 1, as remindings were recollected more often when List 2 items appeared for a longer compared to a shorter length of time. However, in contrast to earlier findings, this effect was not associated with an increase in overall List 1 recall. Our failure to replicate the complete pattern of results could reflect the difference in presentation rates between studies. Rather than using 1 s for the shorter study time condition as in Negley et al. (2018), we chose 2 s to accommodate older adults because they are generally believed to be slower at encoding (e.g., Salthouse, 1996). However, the difference in study time from 2 s to 10 s resulted in negligible benefits for overall List 1 recall in the current study. The lack of benefit to overall List 1 recall from additional study time may have occurred because 2 s was sufficient to cue spontaneous remindings (cf. Benjamin & Tullis, 2010; Hintzman, 2011). It is possible that effect of study time observed by Negley et al. (2018) was the result of the shorter 1 s study time undermining the efficacy of List 2 items as retrieval cues for List 1 at test. To resolve this issue, one could examine how parametric manipulations of study time influence study-phase retrievals and their consequences for memory in an A–B, A–C paradigm.

More generally, the recent studies examining the roles of remindings and recollection of remindings in retroactive effects of memory point out an important contrast with earlier studies examining the roles of remindings and their recollection in proactive effects of memory. For retroactive effects of memory, remindings are associated with facilitation in List 1 recall regardless of whether those remindings are later recollected (Negley et al., 2018). In contrast, for proactive effects of memory, remindings are only associated with facilitation of List 2 recall when those remindings are later recollected (e.g., Wahlheim & Jacoby, 2013). Consistent with Negley et al. (2018), the present study showed that remindings were necessary and sufficient to obtain retroactive facilitation. This finding is consistent with the notion that retrieval practice improves memory for original information. However, there was some ambiguity regarding whether recollecting reminding was associated with additional List 1 recall benefits. One possibility is that the facilitation from the reminding in List 2 elevated younger adults' performance near ceiling, leaving little room for reminding recollection to further increase performance. In addition, the number of observations for older adults in the reminding recollection cell could have limited our ability to detect additional benefits. More research is required to identify when reminding recollection benefits memory beyond remindings alone.

Concluding Remarks

The present findings implicate a critical role for reminding in retroactive effects of memory for older and younger adults. When remindings were recollected, both age groups avoided retroactive interference and showed retroactive facilitation. However, younger adults recollected more remindings than older adults, providing further evidence that older adults experience a recollection deficit. Further research on the factors that moderate the associations among remindings, their recollection, and retroactive effects of memory could fundamentally influence longstanding perspectives regarding age effects on episodic memory. Further research examining the role of remindings and recollection of remindings could also lead to integration-based interventions for the negative effects of retroactive interference that occur when separate events have both shared and distinctive features.

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