EFFECTS OF AGING ON PROACTIVE INTERFERENCE AND FORGETTING

By

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Abstract

Proactive interference is the term that describes an impaired ability to learn information due to interference from previously learned information. Susceptibility to proactive interference increases as we age. It also becomes more difficult to retain newly learned information, leading to an increased rate of forgetting. However, more information is needed to understand if forgetting occurs on its own or is due to an increased susceptibility to proactive interference. To test age differences on proactive interference and proactive interference's influence on forgetting, 44 younger and 18 older adults completed the Rey Auditory Verbal Learning Task (RAVLT) to yield measures of proactive interference and forgetting. Only marginal differences in proactive interference were found between age groups, however older adults had greater forgetting rates compared to younger adults. Further, there was no evidence of a combined effect of age and proactive interference on forgetting rate. This led to the conclusion that forgetting, and not proactive interference, may drive age-differences in memory.

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Table of Contents

Figures

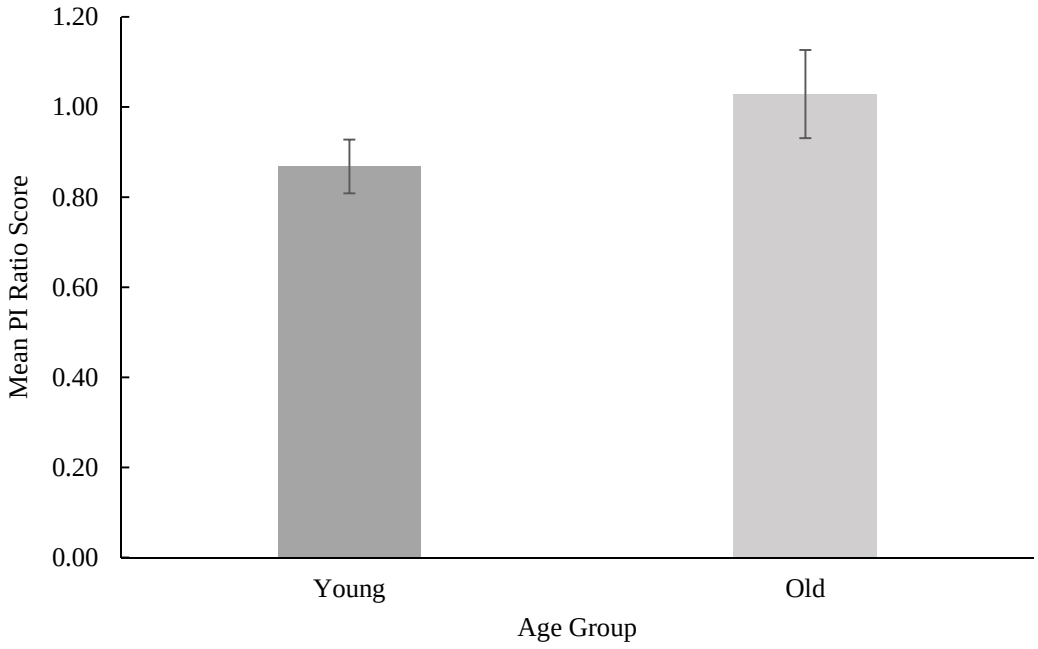

Figure 1. Mean PI Ratio Scores in younger and older adults (means and standard error bars).

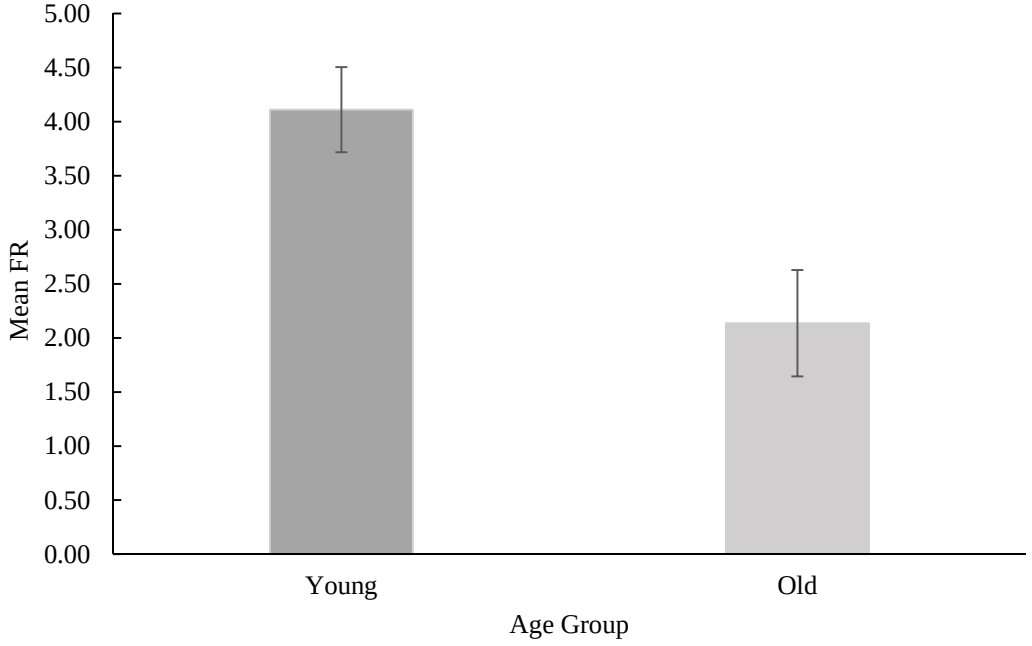

Figure 2. Mean Forgetting Rate in younger and older adults (means and standard error bars).

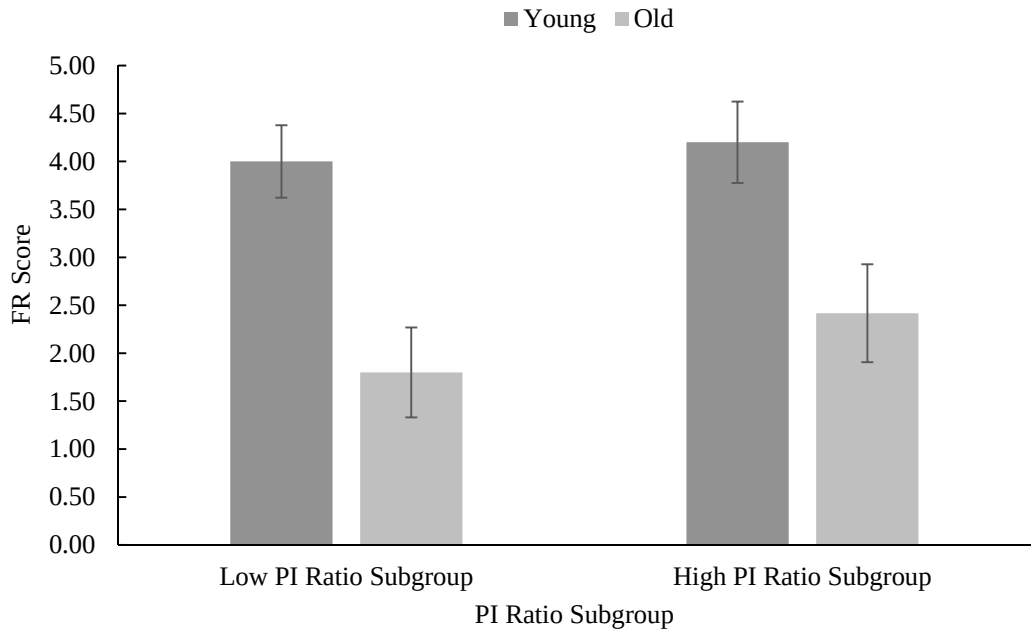

Figure 3. Mean FR scores across High and Low Performance PI Ratio Subgroups for Young and Older Adults (means and standard error bars).

Effects of Aging on Proactive Interference and Forgetting

Human memory is fallible, which may lead to forgetting, defined as an inability to recall information (Nugent, 2011). There are several ways forgetting can manifest, including failures during initial encoding and failures when information is recalled during retrieval (Buschke & Altman Fuld, 1974). These failures may be due to proactive interference (PI), in which material learned previously interferes with the acquisition and/or retrieval of new material (Teague, Langer, Borod, & Bender, 2011). For example, when people learn a friend's new phone number, successful retrieval of that information requires that they correctly inhibit the memory of their friend's previous number. Thus, interference theory provides a direct link between PI and forgetting via an inability to inhibit competing memories (Nugent, 2011).

Research has shown that older adults are more vulnerable to PI, which may account for higher rates of forgetting in this age group (Bowles & Salthouse, 2003). According to interference theory, older adults have increased difficulty efficiently suppressing information that is no longer relevant, resulting in an increased susceptibility to PI and ultimately increased forgetting (Ebert & Anderson, 2009; Emery, Hale, & Myerson, 2008; May, Hasher, & Kane, 1999). For example, one study required participants to memorize the final word of each sentence, with the length of sentences increasing or decreasing across trials (May, Hasher, & Kane, 1999). Greater PI was found when sentence length increased versus decreased across trials, as more information that is no longer relevant needs to be suppressed. Importantly, greater PI was also seen in older adults compared to younger adults.

In another study (Emery, Hale, & Myerson, 2008), younger and older adults completed a working memory span task, in which stimuli switched between words and numbers every three trials. This allowed for PI to "build up" across trials within a category and "release" when

switching to a different category. Results revealed age group differences in performance, consistent with the notion that older adults are more vulnerable to PI, and more susceptible to forgetting, than younger adults.

Another way to measure PI is with the Rey Auditory Verbal Learning Test (RAVLT; Rey, 1964), which also provides a measure of forgetting rate (FR; Saury & Emanuelson, 2017). In this task, participants learn a list of 15 concrete nouns which are repeated across several trials. Specifically, there are 5 immediate recall trials from the same list (List A; denoted by the list and trial number; e.g., A1 to A5), followed by an interference trial requiring individuals to learn a different list of unrelated words (List B; B6). Immediate recall of the first list (List A) is then assessed, followed by a delayed recall trial (A7) after completing a separate task. PI is assessed by comparing the number of items recalled on the first immediate recall trial (A1) to the number of items recalled on the interference trial (B6; Bowler, 2011). FR is measured by subtracting the number of words remembered in the delayed recall trial (A7) from the words remembered in the fifth immediate recall trial (A5). However, to our knowledge, no studies have assessed age group differences in this measure of PI, nor its relation to FR, in younger and older adults.

Therefore, the goals of this study were to explore age differences in FR between cognitively normal younger and older adults, and whether this age effect can be explained by increased PI. To investigate these research questions, participants completed the RAVLT. Analyses were designed to test several hypotheses, including that (1) older adults will experience greater PI than younger adults, (2) older adults will have higher FR than younger adults, and (3) older adults who experience greater PI will forget more than older adults who do not, or younger adults regardless of PI, leading to an interaction between age group and PI on FR.

Methods

Participants

In the current study, 44 young adults (17 females, 18-27 years) and 18 older adults (12 females, 66-79 years old) were recruited. Young participants were recruited from lower division psychology classes at University of California, Riverside, using the university's human participant pool and received course credit for participation. Older participants were recruited from the Riverside metropolitan area and were paid for their participation. All participants gave informed consent for the study. Only young participants who scored $\geq$ 23 on the Mini-Mental State Exam (MMSE), and older participants that scored $\geq$ 22 on the Montreal Cognitive Assessment (MoCA), indicating they were cognitively normal, were included (Tombaugh & McIntyre, 1992; Trzepacz et al., 2015).

Materials

Rey's Auditory Verbal Learning Test (RAVLT) was used to assess susceptibility to PI (Bowler, 2011; Rey, 1964). In the RAVLT, there are 5 immediate recall trials (A1-A5) of unrelated words from the same list (List A), followed by an interference trial (B1) composed of a different list of unrelated words (List B). Immediately after the interference trial, participants are asked to recall the words from List A (A6) unprompted. After a delay, recall for items from the first list (List A) is tested again (A7). A 50-item recognition component then probes participant's ability to identify words from List A, however these data were not included in this study.

To measure proactive interference, the PI ratio measure was calculated as the number of words correctly recalled from the interference list, divided by the number of words correctly recalled from the first immediate recall trial (i.e., B1/A1). Higher numbers indicate lower levels of PI (Bowler, 2011).

FR was measured by subtracting the number of items remembered during the final immediate recall trial from the number of words remembered during the delayed recall trial (i.e., A5-A7). In this way, higher numbers indicate greater FR.

Procedure

Data for the current study was collected as part of a larger study of learning and memory. After informed consent, each participant completed a brief demographics survey. This was followed by a memory test in a magnetic resonance scanner. Then, participants were returned to the lab where they completed the RAVLT and several other neuropsychological measures (e.g., MMSE or MoCA, digit span, vocabulary).

Results

Age group differences in proactive interference

To replicate previous reports that older adults experience greater PI than younger adults, a one-tailed independent-sample *t*-test compared the age groups on the PI ratio score. Effect sizes were examined using Cohen's *d,* with effect sizes between 0.1 - 0.3 considered small, 0.3 - 0.5 considered medium, and > 0.5 considered large (Cohen, 1992). Results revealed that younger adults (1.03 ± 0.42) had higher PI ratio scores than older adults (0.87 ± 0.40), but this effect was only marginally significant, $t(60) = -1.40$, $p = 0.083$, Cohen's $d = 0.39$ (Figure 1).

Age group differences in forgetting

To replicate previous reports that older adults experience higher FR than younger adults, a one-tailed independent-sample *t*-test compared the age groups on FR. As expected, results revealed that FR was significantly higher for older adults (4.11 ± 2.61) than younger adults (2.14 ± 2.09), $t(60) = 3.14$, $p = 0.001$, Cohen's $d = 0.88$ (Figure 2).

Relationship between proactive interference and forgetting

Finally, interactions between PI and FR were examined by comparing four subgroups created using a median split of PI ratio scores separately within the younger and older groups. A 2 Age Group (Younger, Older) × 2 PI Ratio Subgroup (High, Low) factorial ANOVA was conducted with FR scores as the dependent measure. The main effect of Age Group was significant, with older adults (0.87 ± 0.40) having a higher FR compared to younger adults (1.03 ± 0.42), $F(1,58) = 9.73$, $p = 0.003$, $\eta^2 = 0.14$. However, the main effect of PI Ratio Subgroup was not significant, with FR scores in the Low PI ratio group (0.60 ± 0.21) not differing significantly from the High PI group (1.23 ± 0.46), $F(1,58) = 0.41$, $p = 0.53$, $\eta^2 = .006$. In contrast to our prediction, PI ratio subgroups did not interact significantly with age. Older adults in the High PI Ratio Subgroup did not have significantly FR than Older adults in the Lower PI Ratio Subgroup, nor Younger adults in the High or Low PI Ratio Subgroups, $F(1,58) = 0.106$, $p = 0.75$, $\eta^2 = .002$ (Figure 3).

Discussion

The goal of this study was to examine age-related differences in PI and FR, and the effects of PI on FR within each age group. As part of a larger study, younger and older adults competed the RAVLT to assess both PI and FR. In contrast to our first hypothesis, and the existing PI literature, older adults did not exhibit greater PI than younger adults. In support of our second hypothesis, older adults had higher FR than younger adults. However, in contrast to our novel third hypothesis, there was no evidence of a combined effect of age and PI on FR. These findings do not support interference theory, which uses PI to explain increased forgetting.

Previous studies have shown that older adults have a decreased ability to suppress irrelevant information, leading to an increased susceptibility to PI (Bowles & Salthouse, 2003).

However, contrary to this literature, the current study did not find a significant effect of age on PI. One reason for this divergence from the literature may be the task used here. Several studies showing positive age effects on PI use a task designed to 'build up' PI across trials by presenting many items from the same category (Emery, Hale, & Myerson, 2008). In contrast, few words from the RAVLT lists are semantically related. If instead, each of the five recall trials on List A had been a unique set of domestic animals and List B had been zoo animals, there may have been more of a PI effect present because of increased semantically similarity. Another factor that may contribute to the non-significant effect of age on PI was that younger adults did not perform as anticipated, demonstrating higher PI effects than the literature suggests (Ebert & Anderson, 2009; May, Hasher, Kane, 1999; Neath & Surprenant, 2015).

As in previous studies (e.g., Wahlhein, 2014), older adults had higher FR when compared to younger adults. Older adults often perform worse than young adults on a variety of memory tasks (Trahan & Larrabee, 1992). Age differences are more pronounced for recall, which was assessed here, relative to recognition memory (Mitrushina, Satz, Chervinsky, & D'Ella, 1991). There is much debate regarding the cause of these age-related deficits in recall memory (Mitrushina, Satz, Chervinsky, & D'Ella, 1991). Some explanations have focused on a single memory processes, such as those demonstrating that declines in memory may be due to age-differences in attentional processing (Light & Singh, 1987). A critical component of attentional processing is efficiently inhibiting irrelevant information, which as proposed by interference theory, may ultimately affect the rate of forgetting (May, Hasher, & Kane, 1999).

Based on interference theory, we expected older adults with higher PI to have greater FR than both other older adults and younger adults, consistent with the notion that forgetting in these high PI older adults would be driven by an increased difficulty in suppressing irrelevant

information (May, Hasher, & Kane, 1999). However, in the current study, the findings do not support interference theory. There are limited studies linking age, PI, and FR in the context of interference theory, with at least one suggesting that interference theory cannot be used by itself to explain forgetting (Ihalainen, 1968). Thus, additional research will be necessary to assess the types of memory affected by PI and how it relates to increased forgetting with age.

In conclusion, the observed age-related increases in FR in older adults along with the lack of an age effect for PI reflects the multifaceted aspects of age-related forgetting. Given the complexity of memory processes and the broad aspects of forgetting, the interaction between PI ratio scores and FR would be subtle, especially with the small older adult sample size. Another consideration is perhaps if there had been an equal amount of older and younger adults, and more variation in age-range, there might have been more power to detect an interaction between PI ratio scores and FR, and there may have been more significant differences in PI ratio scores. Additionally, this study was conducted as a part of a larger study, which may have fatigued the participants, impacting their performance on the RAVLT. Future studies could use other tasks to assess PI and FR separately.

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