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The Effects of Age in Four Alternative Forced Choice Item and Associative Recognition Tasks

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Abstract

Seventy-three young and 84 older adults were taught interactive imagery as a strategy for learning word pairs. In the control condition, participants viewed word pairs one at a time and formed an interactive image for each. In the experimental condition, participants first formed individual mental images for both the cue and the target, and then formed an interactive image for the pair. Participants in both conditions then completed four alternative forced choice item and associative recognition tasks that avoid influences of age differences in retrieval strategies such as recall-to-reject. Unlike findings with typical yes-no recognition tests, associative recognition was superior to item recognition in the control condition. This effect was attenuated in the experimental condition. Older adults had poorer recognition memory for both associative and item tests, with a larger age difference for recognizing new associations.

Keywords

Associative recognition; aging; strategies; encoding; retrieval

Evidence suggests that older adults do not perform as well as younger adults on associative recognition tasks, even when performance is equated on item recognition (Castel & Craik, 2003; Healy, Light & Chung, 2005; Light, Patterson, Chung, & Healy, 2004; Naveh-Benjamin, 2000; Naveh-Benjamin, Guez, Kilb, & Reedy, 2004; Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003). This deficit in recognizing episodic associations is often explained by a reduction in recollection coupled with relatively preserved familiarity in old age. According to Naveh-Benjamin's associative deficit hypothesis, (Naveh-Benjamin, et al., 2003) older adults have difficulty binding together single units of information during encoding and subsequently retrieving that linked information (see also Chalfonte & Johnson, 1996). Those single units of information can be two items, such as two words, an item and its context, or two elements of a context.

Recent evidence suggests a possible role for strategy usage as a contributor to older adults' associative deficit. Naveh-Benjamin, Brav & Levy (2007) presented young and older adults with unrelated word pairs at study followed by item and associative recognition tests. Three groups of participants were either (a) given standard intentional learning instructions only, or

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were told that creating a sentence linking words improves performance and were encouraged to do so (b) during encoding or (c) told to use the sentence generation sentence strategy both during encoding and at retrieval by relating test items to sentences they created at study. Under intentional learning instructions alone, older adults showed a reliable associative deficit relative to item recognition. This associative deficit decreased when instructions encouraged use of effective sentence mediators at encoding and decreased even further when encoding instructions were coupled with encouragement to retrieve the mediator when tested as a means of recognizing the correct association. Older adults reported less spontaneously use of associative strategies unless instructed to do so.

Most studies examining age effects in associative recognition utilize yes/no recognition tasks. Yes/no forced recognition tests place high demands on self-initiated retrieval strategies. Participants must rely on recall-to-reject processing to differentiate between intact and rearranged pairs. According to the strategic retrieval hypothesis (Cohn, Emrich, & Moscovitch, 2008), the age-related associative deficit is specific to the nature of the memory test. According to this hypothesis, older adults perform well on associative recognition tasks when demands on strategic retrieval abilities are minimized. For instance, Cohn et al. (2008) showed that intact pairs show an equivalent advantage for young and old adults over items consisting of old words that had not been originally paired at study, a condition not requiring recall-to-reject strategies. Several other lines of evidence converge to suggest that age differences in effective use of retrieval strategies contribute to the associative deficit, including age equivalent hit rates in associative recognition (Castel & Craik, 2003; Light, et al. 2004), large age effects in recall-to-reject processing of rearranged pair lures where good memory cues are unavailable at test (Healy, et al. 2005). Finally, evidence suggests that older adults are as successful at recall-to-reject processes as younger adults under conditions in which they need not rely solely on self-initiated retrieval processes, such as when rejecting unrelated, rearranged lures whose members had originally been studied within related pairs (Patterson & Light, 2008).

The present study used a different recognition test format – the alternative forced-choice (AFC) test. In AFC tasks, participants are required to select an intact pair from a set including rearranged lures. Correct discriminations can be based on a relative difference in associative familiarity (Clark, Hori, & Callan, 1993) instead of relying on recall-to-accept or recall-to-reject. Arguably, AFC tasks make fewer demands on self-initiated retrieval strategies than yes/no recognition. A question of interest was whether the different test format would affect the magnitude of the associative deficit.

This study also manipulated the nature of the encoding instructions. We instructed the use of interactive imagery to form new associations (e.g., Dunlosky, Hertzog, & Powell-Moman, 2005; Hertzog & Dunlosky, 2006). In addition, we manipulated whether individuals first attended to each word in isolation before being presented with the intact pair for imagery. They were instructed to form a vivid image of the single word. On the one hand, the manipulation could enhance the distinctiveness of each element of the pair (e.g., Smith & Hunt, 2000), which could benefit item recognition above associative recognition, potentially amplifying the magnitude of the associative deficit. On the other hand, having people image individual words before forming an interactive image could enhance interactive imagery quality, thereby raising older adults' associative recognition performance. The question of interest was whether focusing young and older adults' on processing individual words within a pair prior to doing association encoding would affect the age-related associative deficit.

Method

Participants

Young adults were recruited from the Georgia Institute of Technology psychology participant pool and received course credit for their participation. Older adults were recruited from the Atlanta area and received \$25 for participation. Data from 73 young (18–33 years; mean age 19.6, mean education level 14.69 years) and 84 older adults (60–80 years; mean age 69.9 years, mean education level, 16.30 years) are presented here.

Materials

Four hundred twenty words were selected from the MRC Psycholinguistics Database (Coltheart, 1981) and were between 3 and 9 letters in length. Two hundred forty of these words were assigned to unrelated study pairs. The remaining 180 words were used as foils in the item recognition test (see below). In all, four different study-test lists were constructed with the same two hundred forty words. Lists 1 and 2 contained identical study pairs, but different rearranged pairs were created for use as foils in the associative recognition test. Lists 3 and 4 used different combinations of the words from Lists 1 and 2 to form different study pairs and in lists 3 and 4 different rearranged pairs were created for use as foils in the associative recognition test. Assignment of lists to participants was counter-balanced.

Procedure

Participants read detailed instructions explaining the experimental tasks and how to form interactive images including examples of how interactive imagery can be used to learn word pairs. Participants were assigned to either the control or the experimental condition. Those in the control condition (39 young, 42 old) viewed 120 unrelated word pairs one at a time—young adults for 3 sec. and older adults for 6 sec. each. Participants were instructed to form an interactive image for the two words in each pair as quickly as possible and to press the space bar as soon as they had done so. Participants in the experimental condition (34 young, 42 older) first viewed each member of the pair for either 1.5 sec (young) or 3 sec. (older) and then received the same interactive image instructions, with 3 sec for young and 6 sec for older adults for constructing the interactive image. Different presentation times were used because Robinson, Hertzog, and Dunlosky (2006) showed that older adults take longer to form interactive images when instructed to do so (another manifestation of slowed information processing in old age).

For both groups, individuals gave a judgment of learning (JOL) for each association after interactive imagery. Participants in the experimental condition also made a JOL for each item after imaging each word, but before interactive imagery. The JOL data are not presented in the current report.

Following study, participants in both the control and experimental groups completed four-alternative forced-choice (4AFC) item and associative recognition tests in counterbalanced order. The 4AFC procedure required guessing; that is, individuals were forced with each item to select one of the four response options before continuing to the next item. Items were randomly assigned to be included in either the item test or the associative test. The associative recognition test was made up of 60 trials; each consisting of 1 intact pair and 3 rearranged foils (each member of the pair having been studied but with a different partner). Participants were instructed to select the pair that was viewed at study by pressing a corresponding key on the keyboard. The item recognition test was made up of 60 trials, each consisting of 1 word that was seen at study and 3 new (previously unseen) foils. Participants were instructed to select the word that was seen at study by pressing a corresponding key on the keyboard. Only one word from a studied pair was tested for item recognition. For both the item and associative

recognition tests, correct responses were randomly presented in one of the four positions on each test trial.

Results

Figure 1 shows the mean accuracy for young and older adults' item and associative recognition tests.

A 2 (age group: young vs. old) $\times$ 2 (condition: control vs. experimental) $\times$ 2 (test type: item vs. associative) mixed analysis of variance (ANOVA) was conducted on mean recognition accuracies. The main effect of age was significant, [$F(1,153) = 24.53, p < .001$, partial $\eta^2 = .14$] with younger adults demonstrating higher accuracy ($M = 0.78$) than older adults ($M = 0.65$). The main effect of test type was also significant, [$F(1,153) = 10.26, p < .05$, partial $\eta^2 = .06$], with more accurate performance on the associative ($M = .73$) than on the item ($M = .70$) recognition test. There was also a significant test type $\times$ age group interaction [$F(1,153) = 8.61, p < .05$, partial $\eta^2 = .053$]. Across conditions, younger adults' performance was more accurate for the associative ($M = .82$) than the item ($M = .74$) recognition test. For older participants, the difference in performance on these tasks did not approach significance ($M_s = .73$ for each). The test type $\times$ condition interaction was also significant [$F(1,153) = 11.34, p < .05$, partial $\eta^2 = .07$]. There was a larger difference in accuracy between item and associative recognition in the control condition ($M_s = .66$ and $.74$, respectively) than in the experimental condition ($M_s = .73$ each). Thus, instructions orienting individuals to image each word separately boosted item recognition. However, this effect did not have any influence on age differences between the two types of recognition tests. The three-way interaction between age, condition, and test type did not approach significance [$F(1,153) < 1.0$].

Given the importance of the associative deficit hypothesis in the literature, separate age $\times$ test type ANOVAS were conducted for each condition. For the control condition, the main effects of both age [$F(1, 79) = 14.86, p < .001$, partial $\eta^2 = .16$] and test type [$F(1, 74), p < .001$, partial $\eta^2 = .24$] were significant. Accuracy was higher for young than older adults ($M_s = .74$ and $.66$, respectively), and for the associative than the item recognition test ($M_s = .74$ and $.66$, respectively). The age group $\times$ test type interaction was also significant [$F(1, 79) = 4.62, p < .05$, partial $\eta^2 = .06$]. Both age groups demonstrated higher accuracy rates for associative than item recognition. However, for young adults, this difference was greater ($M_s = .83$ and $.72$, respectively, $t(38) = 5.46, p < .001$) than for older adults ($M_s = .65$ and $.61$, respectively, $t(41) = 1.90, p > .05$).

For the experimental condition, the main effect of age was significant [$F(1, 74) = 9.99, p < .05$, partial $\eta^2 = .20$], with higher accuracy scores for younger ($M = .79$) than older ($M = .67$) participants. Unlike in the control condition, the main effect of test type was not significant [$F(1, 74) < 1$]. Finally, the test type by age group interaction was significant [$F(1, 74) = 4.02, p < .05$, partial $\eta^2 = .05$]. Accuracy for young participants was somewhat, though not significantly, higher for associative ($M = .81$) than item ($M = .77$) recognition ($t(33) = 1.54, p > .05$). For the older participants, the non-significant difference went in the opposite direction (M associative = $.65$, M item = $.69$; $t(41) = 1.41, p > .05$).

Discussion

The 4AFC test format and interactive imagery instructions produced an atypical effect given the existing literature on the age-related associative deficit. The classic pattern of lower associative recognition performance relative to item performance (e.g., Naveh-Benjamin, 2000) was reversed. Instead, the control condition produced an associative recognition advantage for both age groups. It is unlikely this is a unique effect of instructed imagery use

because Dunlosky et al. (2005) found no performance differences between imagery and sentence strategies in associative cued recall. Furthermore, encoding and retrieval instructions alone are insufficient to produce the reversal with yes-no recognition tests (Naveh-Benjamin et al., 2007), even when they eliminate the age-related associative deficit. This atypical associative recognition advantage was reduced in the experimental condition, where instructions asked for images of each word immediately prior to generating interactive imagery to mediate the association between the words. Older and younger adults both benefitted from the item-specific encoding, possibly due to the enhancement of item-specific distinctiveness (cf. Luszcz, Roberts, & Mattiske, 1990).

These findings suggest the importance of test format for establishing an associative deficit and constrain interpretation of its origins. In yes/no associative recognition tasks, age differences may emerge because of age differences in quality of inferential mechanisms such as recall-to-reject that are tied to retrieval searches and evaluation of retrieval products (Cohn et al. 2008). The AFC test format attenuates this effect because older adults can select the intact pair among the rearranged lures, allowing participants to benefit from the associative familiarity of the intact pair, compared with the rearranged lures.

In the control condition, AFC boosted associative recognition performance above item recognition in both age groups, but older adults still manifested an associative memory deficit relative to young adults. Moreover, the fact that the manipulation of individual word imagery boosted item recognition, yet still produced an age $\times$ test interaction, provides new, additional support for the hypothesis that forming new associations is specifically impaired in older adults. Indeed, from a methodological perspective this outcome is useful evidence favoring an age-related associative memory deficit, because the disordinal interaction in the experimental condition cannot be attributed to scaling artifacts (Loftus, 1978). Thus, these outcomes indicate that the age-related associative deficit cannot merely be attributed to retrieval strategies in yes-no recognition tests as specified by the strategic retrieval hypothesis.

Different presentation times were used to insure similar success rates in forming interactive images, given age-related slowing of imagery processes. Nevertheless, we found reliable age deficits in both associative and item recognition. The low demands on self-initiated retrieval in the forced-choice paradigm were not enough to equate older participants' recognition accuracy with that of young, even though their item recognition was reliably enhanced by item-specific imagery in the experimental condition.

Further research explicitly contrasting the yes-no and AFC formats in a randomized experiment would be a logical replication and extension of this study. Another important question is the mechanism or mechanisms that generate the age-related associative deficit. It may be due to fundamental age changes in neurobiological substrates responsible for memory-binding in the brain (e.g., Li, Naveh-Benjamin, & Lindenberger, 2005; Shing, Werkle-Bergner, Li, & Lindenberger, 2008). Given that Naveh-Benjamin et al. (2007) eliminated the yes-no task's age-related associative deficit with encoding and retrieval instructions, the associative deficit observed in this study could also reflect age differences in strategies used in the AFC task. Age differences in strategies for comparing retrieval-supported evidence in simultaneous AFC recognition tests are certainly possible, but as of yet the strategies that may be in play have not been well characterized or understood. Additional experiments regarding the associative deficit hypothesis in the context of alternative test procedures and instructional manipulations are warranted.

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Figure 1. Mean accuracy for young and older adults in the item and associative tests. Error bars represent standard errors of the mean.