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Recognition Memory Measures Yield Disproportionate Effects of Aging on Learning Face-Name Associations

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Abstract

No previous research has tested whether the specific age-related deficit in learning face-name associations that has been identified using recall tasks also occurs for recognition memory measures. Young and older participants saw pictures of unfamiliar people with a name and an occupation for each person, and were tested on a matching (in Experiment 1) or multiple-choice (in Experiment 2) recognition memory test. For both recognition measures, the pattern of effects was the same as that obtained using a recall measure: more face-occupation associations were remembered than face-name associations, young adults remembered more associated information than older adults overall, and older adults had *disproportionately* poorer memory for face-name associations. Findings implicate age-related difficulty in forming and retrieving the association between the face and the name as the primary cause of obtained deficits in previous name learning studies.

Keywords

aging; proper names; recognition memory; transmission deficit hypothesis; associative deficit hypothesis

Older adults express concern about a variety of age-related changes in memory, but they often report *specific* difficulty with names, both in learning names of people they just met and also in recalling the names of well-known individuals (e.g., Cargin, Collie, Masters, & Maruff, 2008; Cohen & Faulkner, 1984). Past research has demonstrated that older adults fail to name pictured celebrities more often than young adults (e.g., Cross & Burke, 2004; Maylor, 1990), and the age-related decline is larger for producing proper names than common nouns (Evrard, 2002; Rendell, Castel, & Craik, 2005). In particular, there are disproportionate age-related increases in tip-of-the-tongue (TOT) states for well-known proper names (James, 2006).

James (2004) found that older adults also show greater impairment in learning proper names than learning other biographical information in association with a new face (see also Barresi, Obler, & Goodglass, 1998). James gave participants both a name and occupation to learn in association with a presented face, and both young and older adults learned occupations more readily than names, replicating past research (e.g., McWeeny, Young, Hay, & Ellis, 1987). Older adults had more difficulty learning both types of information than young adults, but there was a disproportionately large age-related deficit in learning the names. James (and Baressi et

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al.) tested memory using a recall task, in which participants were to produce an associated name and occupation on test presentations of a face. In the present experiments we adopted similar methods, but tested face-name and face-occupation learning using two different recognition memory tasks.

Our goal was to determine whether the specific age-related deficit in learning and memory for names is also obtained using measures of recognition memory. The learning paradigm used by James (2004) and Baressi et al. (1998) critically involves several separable cognitive processes: face recognition, memory for the specific items (names and occupations) that were presented in the experiment, the formation and retrieval of new associations between those items (the name and/or the occupation) and a particular face, and the ability to retrieve and produce the phonological sequences that comprise the words (the names and occupations) when given the face as a cue. The present experiments were designed to specifically focus on the extent to which older adults' disproportionate deficit in learning names for the faces is due to age-related declines in forming and/or retrieving associations.[1]

Face recognition is known to decline in aging (e.g., Backman, 1991; Memon & Bartlett, 2002; Naveh-Benjamin, Guez, Kilb, & Reedy, 2004; Searcy, Bartlett, & Memon, 1999; Smith & Winograd, 1978). Because face recognition was not a cognitive process of interest in the current research, we adopted a dependent measure developed by McWeeny et al. (1987) that allowed us to disentangle age effects on face recognition from age effects on associations between the faces and information about the pictured people. Specifically, we supplemented our primary analyses (percentage correct) with analyses of two types of errors: name errors (where the occupation of the pictured person was correctly recognized but the name was not) and occupation errors (where the name was correctly recognized but the occupation was not). These error types necessarily involve the correct identification of the face, as demonstrated by the correct recognition of one piece of information (either the name or the occupation) in response to the face (e.g., the participant thinks "I know he is the painter, but I do not know which of these is his name"). To have such an error, a participant must have correctly identified the face, and thus analyses of these error types factor out age differences in face recognition.

Turning to age differences in episodic recognition of studied names, Naveh-Benjamin et al. (2004) demonstrated older adults' reduced ability to discriminate names that were presented in an experimental session from names that were not, and further showed that the age changes in name recognition are smaller than age changes in the recognition of face-name associations. Troyer, Hafliger, Cadieux, and Craik (2006) found that older adults were not significantly impaired in recognizing names that had been presented in lists, but their data indicate that older adults had more difficulty than young adults matching names to the faces with which they were presented for learning (Figure 3, p. P70; they did not analyze these data for age effects because they gave older adults longer study exposure times than young adults). Relatedly, in a test of episodic recognition of studied faces, Bastin and Van der Linden (2006) found age stability in face recognition, coupled with age decrements in the recognition of face-face pairs or face-location pairs. Such findings indicate that although there may be small age declines in the ability to recognize studied items, older adults' deficits in face-name learning tasks cannot be due to failures of item recognition alone. Furthermore, while these experiments demonstrated specific age deficits in associative recognition, none systematically compared young and older adults' recognition of face-name associations with their recognition of other types of associations.

[1]Cohn, Emrich, and Moscovitch (2008) argue that older adults' difficulty is not due to a general age-related deficit in associative binding but rather to an age-related decline in the ability to use strategic processes to recollect the formed associations. The current experiments do not permit us to distinguish between these possibilities.

Older adults are known to have difficulty compared to young adults in forming and retrieving a wide range of novel associations between items (e.g., Bastin & Van der Linden, 2006; Burke & Light, 1981; Light, 1991; Naveh-Benjamin, 2000; Naveh-Benjamin, Hussein, Guez, & Bar-On, 2003; Naveh-Benjamin et al., 2004; Troyer et al., 2006; see Old & Naveh-Benjamin, 2008, for a recent meta-analysis of relevant studies). Theoretical accounts of age differences on such tasks typically include an associative or binding mechanism that is in some way negatively impacted by normal aging (e.g., Bayen, Phelps, & Spaniol, 2000; Chalfonte & Johnson, 1996; MacKay & Abrams, 1996; MacKay & Burke, 1990; Mitchell, Johnson, Raye, Mather, & D'Esposito, 2000; Naveh-Benjamin, 2000). In the discussion section, we will consider in detail differences between these explanations for older adults' deficits in forming and remembering new associations. However, what these approaches have in common is that they predict age-related declines in the ability to encode and/or retrieve associations between the pictured faces and the information about the people in the pictures. Furthermore, these frameworks all predict that the age-related difficulty with novel associations will impact memory on both recall and recognition memory measures.

Older adults also show declines in some word retrieval and speech production processes, and age differences in these processes could contribute to the findings of previous research on face-name association learning (e.g., Barresi et al., 1998; James, 2004). There is a substantial age-related increase in the occurrence of TOT states (e.g., Burke, MacKay, Worthley, & Wade, 1991; Heine, Ober, & Shenault, 1999), in which people know that they know a word but are unable to currently produce the desired term. People of all ages can fail to retrieve all types of words (nouns, adjectives, etc.), but TOTs are particularly common for proper names, especially for older adults (e.g., Evrard, 2002; James, 2006; Rastle & Burke, 1996). TOTs for names appear to reflect failures to retrieve some or all of the phonology of the target name (e.g., Burke, et al.; James & Burke, 2000; Rastle & Burke; White & Abrams, 2002). If the process of retrieving the phonology for production of a known word, especially a name, is impaired for older adults, this may contribute to age-related deficits that have been established in face-name association learning tasks when memory is tested via recall measures. Correct responses on a recall task depend on both memory for the correct information and the ability to retrieve and produce the phonology of the remembered information. The recognition memory measures used in the present experiments were adopted because they do not require participants to retrieve and produce the phonology of the name from memory, eliminating concerns that difficulty with phonological access (as occurs during a TOT state) contributes to any identified deficits.

The present experiments test whether the age-related deficit for recognizing names learned in association with faces is larger than the deficit for recognizing other types of information learned in association with faces. In other words, we are testing whether the disproportionate difficulty in name learning shown in James (2004) was influenced by the need for participants to engage in phonological retrieval of the names. Inasmuch as difficulty forming and/or retrieving an association between the name and the face is responsible for the age-related deficit in name memory, older adults should demonstrate a specific problem with name memory when tested on recognition tasks as well as on recall tasks. Under this explanation, it will not matter whether the role of phonological retrieval is minimized (as on a recognition memory measure) or not: The critical difficulty lies in the associative component of the task. If recall and recognition memory measures yield the same pattern of age differences in name learning, then the face-name association is implicated as the primary determinant of the age effects. However, if recognition memory measures do not yield disproportionate impairment in older adults' name memory, then retrieval of the phonology of the name is implicated as an important contributor to the age differences obtained when using recall tasks.

Experiment 1

This experiment tested learning and memory for names and occupations associated with previously unknown people as measured on a matching task. Following the procedure of McWeeny et al. (1987) and James (2004), a man's face was paired with both a last name and an occupation in one study presentation. In the present experiment, on test presentations the face was presented and participants were to select the name and occupation for that person from a provided list containing targets and distractors. The purpose was to determine whether the specific deficit in learning face-name associations evidenced by older adults on recall tasks would be found on a measure that does not require retrieval of the phonology of the name from memory.

Method

Participants—Twenty-four young adult participants (ages 18–30, $M = 22.17$; $SD = 3.52$) were recruited from the University of Colorado, Colorado Springs, and received extra credit in a psychology class for participation. Twenty-four older adult participants (ages 61–85, $M = 71.71$; $SD = 6.93$) were recruited from a panel of healthy, community-dwelling volunteers, and were paid $10 for participation. No participant from James (2004) participated in this experiment. Young adults had approximately the same number of years of education ($M = 14.96$, $SD = 1.49$) as older adults ($M = 14.75$, $SD = 2.36$), $t < 1$, and had lower scores on a 40-item vocabulary test (Shipley, 1940; $M = 29.58$; $SD = 3.53$) than older adults ($M = 34.39$; $SD = 2.97$), $t(45) = 5.05$, $p < .01$. All older adults passed a short screening test for dementia (the Mini Mental Status Exam; MMSE, Folstein, Folstein, & McHugh, 1975) with at least 27 out of 30 items correct.

Materials and Procedure—Stimuli were identical to those used in Experiment 2 of James (2004). There were black and white pictures of 12 unknown men who appear to be between the ages of 30 and 60 (to avoid ingroup/outgroup biases for either age group). Following the procedure of James (2004), each picture was paired with a last name and an occupation. Some of the names and occupations were ambiguous (i.e., they were the same word), and the ambiguous items were presented to half the participants as a surname (e.g., Mr. Farmer) and to half the participants as an occupation (e.g., he is a farmer). Each stimulus person was paired with one ambiguous item (e.g., the name Mr. Farmer) and one unambiguous item (e.g., He is a dentist), so that for each face either the name or the occupation was an ambiguous term and the other item was not ambiguous. The set of 12 faces was shown, one face at a time on a separate sheet of paper for 3–4 s each. The name and occupation were typed below each picture, and each stimulus person was also verbally introduced to the participant by the experimenter (e.g., “This is Mr. Farmer, he is a dentist”)

In the testing phase, all 12 faces were presented in different randomly-reordered arrays (always different than the order presented in the study phase) on one large sheet of paper. The participant attempted to identify the information paired with each face by matching information from a list that included the 24 actual stimuli as well as 24 distractor items. Distractor items were similar in frequency and length (in letters and syllables) to the actual stimuli. Like the actual stimuli, distractor items included words that could only be occupations, words that could only be names, and ambiguous words that could be either names or occupations. List items were in all-capital letters so that there was no cue as to whether an item was a name or an occupation. The list was presented adjacent to the faces so that participants could easily refer to the list while considering a stimulus face. Participants were told they could write on the list (e.g., by tallying next to list items when they used them), and there was no time limit given for the test sheets. When the participant had filled in the response sheet as completely as he or she could, the experimenter went through the responses and indicated to the participant whether each response was correct or not. For incorrect answers (including commissions and omissions), the experimenter re-presented the correct information to the participant. The testing phase continued until information for the entire set of faces was correctly matched on two consecutive response sheets or until 12 response sheets were presented. Participants completed a demographics sheet and the vocabulary test, and older adults were given the MMSE.

Results and Discussion

Young adults reached the criterion to complete the session in fewer testing sheets (M = 7.92, SD = 2.50) than older adults (M = 11.42, SD = 1.28), $t(46) = 6.10$, $p < .01$, indicating that the task was easier for young than older adults. Note, however, that young adults' average of almost 8 testing sheets to reach criterion indicates that this is a very difficult task for both age groups. As the mean for older adults indicates, many older participants (79%) failed to reach the criterion of completing two response sheets with entirely correct responses (compared to only 13% of young participants)

To control for differences in number of attempts to retrieve name and occupation information, percentage correct responses was computed out of the number of presented faces (e.g., if a participant completed the session in 10 testing sheets, then the number of correct names and the number of correct occupations were each divided by 120 and multiplied by 100 to yield percentages). These data were analyzed in a 2 (young vs. older adults) × 2 (name vs. occupation information) mixed factorial analysis of variance (ANOVA). As shown in Figure 1 (left panel), young adults outperformed older adults overall, $F(1, 46) = 38.48$, partial $\eta^2 = .46$, $p < .01$, and face-occupation associations were better remembered than face-name associations, $F(1, 46) = 65.45$, partial $\eta^2 = .59$, $p < .01$. Age interacted with information type, $F(1, 46) = 7.96$, partial $\eta^2 = .15$, $p < .01$, because older adults did disproportionately worse than young adults on face-name matching compared to face-occupation matching, although age differences were significant for both face-name matching, $t(46) = 6.47$, $p < .01$, and face-occupation matching, $t(46) = 4.58$, $p < .01$.

As in James (2004) and McWeeny et al. (1987), we also analyzed name errors (where the occupation was correctly matched but the name was not) and occupation errors (where the name was correctly matched but the occupation was not) to factor out age differences in face recognition. By definition, to have one of these errors, one piece of information must be correctly recognized in association with the face, indicating that the correct individual has been identified. This ANOVA yielded the same pattern of effects, including the critical interaction of age and error type that demonstrates a disproportionate deficit in name matching for older adults, $F(1, 46) = 9.00$, partial $\eta^2 = .16$, $p < .01$ (see Table 1).

We performed additional analyses to control for the result that some participants (particularly older adults) failed to reach the criterion to end the testing session. First, we analyzed the data from only the first testing sheet (see Table 2). As with the entire data set, this analysis showed that young adults outperformed older adults overall, $F(1, 46) = 14.75$, partial $\eta^2 = .24$, $p < .01$, and that face-occupation associations were better remembered than face-name associations, $F(1, 46) = 49.84$, partial $\eta^2 = .52$, $p < .01$. However, age did not interact with information type, $F < 1$, partial $\eta^2 = .02$. In the initial stages of learning, it appears that face-name associations are not differentially difficult for older adults, but across the testing phase, older adults' face-occupation matching improved more than their face-name matching. We also re-scored the data so that if a participant had completed the experiment in fewer than 12 test sheets, all of the "missing" data were scored as correct (i.e., we assumed that if a participant had correctly matched all the information on two consecutive response sheets, that they would continue to match information correctly until the last, or 12th, testing sheet). As with the entire data set, this analysis showed that age interacted with information type, $F(1, 46) = 11.23$, partial $\eta^2 = .$

20, $p < .01$, indicating that ending the experiment when participants reached the criterion did not alter the pattern of effects.

We also performed an analysis incorporating the results of James (2004, Experiment 2; see Figure 1, right panel) to compare to the results of the matching experiment. This 2 (young vs. older adults) × 2 (name vs. occupation information) × 2 (recall vs. matching task) mixed factorial ANOVA on percentage correct indicated neither a main effect of memory measure nor any interaction of memory measure with any variable, all *F*s < 1. This failure to find an interaction with memory measure indicates that the primary locus of older adults' difficulty in face-name learning is due to a deficiency in encoding and/or retrieving the association rather than in retrieving the phonological form of the information.

The lack of a main effect of memory measure was surprising: We expected the matching task to be easier than the recall task. Participants may have failed to take advantage of the list of items provided for them, and instead performed the matching task as if it were a recall task, generating information from memory. To explore this possibility, we reviewed participants' errors and discovered that one young participant guessed one name that was not on the provided matching list. While we were surprised that anyone would ever generate a name not found on the list, the fact that it only occurred once indicates that participants did use the list to constrain their responses. Nevertheless, in Experiment 2 we implemented a different type of recognition memory measure.

Experiment 2

To ensure that our recognition test required participants to pay close attention to the presented options (and not perform the experiment as if it were a recall task), we developed a multiple-choice recognition memory measure. In all other respects, this experiment was identical to Experiment 1. The goal was to determine whether older adults' specific deficit in face-name learning found on recall tasks would be obtained when participants do not have to retrieve the phonology of the name from memory and instead must recognize the name from multiple-choice options.

Method

Participants—Twenty-four young adult participants (ages 18–30, $M = 21.65$, $SD = 3.43$) were recruited from the University of Colorado, Colorado Springs, and received class extra credit for participation. Twenty-four older adult participants (ages 59–84, $M = 70.50$, $SD = 6.79$) were recruited from a panel of volunteers, and were paid \$10. No participant from Experiment 1 or James (2004) participated in this experiment. Young adults had fewer years of education ($M = 14.04$, $SD = 1.33$) than older adults ($M = 16.68$, $SD = 2.32$), $t(43) = 4.71$, $p < .01$, and had lower scores on the Shipley (1940) vocabulary test ($M = 29.76$; $SD = 3.52$) than older adults ($M = 34.64$; $SD = 2.92$), $t(41) = 4.95$, $p < .01$. All older adults passed the MMSE (Folstein et al., 1975) with at least 27 out of 30 items correct. Data from one additional older participant (who scored a 23 on the MMSE) were excluded from analyses.

Materials and Procedure—Stimuli were identical to those in Experiment 1. A multiple-choice recognition task was developed by creating four options for each face, for each type of information. One option was the correct information, two were names or occupations belonging to other pictured people, and one was information not presented in the experiment. In each testing round, faces were presented one at a time on a separate sheet of paper, in the same random order for all participants, with a different order of faces for each testing round. The multiple-choice options were presented in two columns below each face so that participants could easily refer to the face while considering the options. One column contained four names and the other column contained four occupations. The correct name and occupation were intentionally never presented on the same line within each column (i.e., if the correct name was option “b” in the name column, the correct occupation was never option “b,” to ensure that participants could not use memory for the occupation and rely on an option’s position in the list to guess the correct name). For each testing round, there was a different order for both the name and the occupation options. The participant was to choose one item from each column. Incorrect answers were corrected verbally to the participant, and the session continued until information was correctly selected for the entire set of faces twice consecutively or until the set was presented 12 times. Participants completed the demographics sheet, vocabulary test, and (for older adults) the MMSE.

Results and Discussion

Young adults completed the session in fewer presentations of the set of faces ($M = 7.71$, $SD = 3.04$) than older adults ($M = 10.83$, $SD = 2.18$), $t(46) = 4.09$, $p < .01$, indicating that the information was learned more readily by young than older adults. As in Experiment 1, many older participants (75%) failed to reach the criterion of completing two testing rounds with entirely correct responses (compared to only 13% of young participants). Participants reached criterion to end the session in slightly fewer rounds than either the matching task of Experiment 1 or the recall task of James (2004, Exp. 2). However, a 3 (memory measure: recall, matching, multiple choice) × 2 (age group) ANOVA on number of rounds to criterion found no main effect of memory measure, $F(2, 138) = 2.13$, $p > .12$, and no interaction of memory measure with age, $F < 1$, indicating that the multiple choice task was still quite challenging for young and older adults.

Percentage of presented faces with correct responses was analyzed in a 2 (young vs. older adults) × 2 (name vs. occupation information) mixed factorial ANOVA. As shown in Figure 1 (middle panel), young adults outperformed older adults overall, $F(1, 46) = 33.19$, partial $\eta^2 = .42$, $p < .01$, face-occupation associations were better remembered than face-name associations, $F(1, 46) = 91.18$, partial $\eta^2 = .67$, $p < .01$, and age interacted with information type, $F(1, 46) = 24.15$, partial $\eta^2 = .34$, $p < .01$. Although young adults significantly outperformed older adults for both face-name and face-occupation recognition, older adults did disproportionately worse than young adults on the multiple-choice test for face-name associations, $t(46) = 6.43$, $p < .01$, than for face-occupation associations, $t(46) = 3.89$, $p < .01$.

As in Experiment 1, we next analyzed name errors (where the occupation was correctly recognized but the name was not) and occupation errors (where the name was correctly recognized but the occupation was not). This ANOVA yielded the same pattern of effects, including the critical interaction of age and error type that demonstrates a disproportionate deficit in face-name association recognition for older adults, $F(1, 46) = 24.14$, partial $\eta^2 = .34$, $p < .01$ (see Table 1).

Also as in Experiment 1, we analyzed the percentage correct data from only the first testing round. For these data, the critical interaction of age and item type was significant, $F(1, 46) = 4.25$, partial $\eta^2 = .09$, $p < .05$ (see Table 2). We also re-scored the data so that if a participant had completed the experiment in fewer than 12 testing rounds, all of the “missing” data were scored as correct. Again, the interaction of age and item type was significant, $F(1, 46) = 22.73$, partial $\eta^2 = .33$, $p < .01$.

We also performed an analysis incorporating the results of James (2004, Experiment 2; see Figure 1, right panel) with the results of the multiple-choice experiment. This 2 (young vs. older adults) × 2 (name vs. occupation information) × 2 (recall vs. multiple-choice task) mixed factorial ANOVA indicated a main effect of memory measure, $F(1, 92) = 76.98$, partial $\eta^2 = .46$, $p < .01$, with better scores on multiple-choice than recall. There was an interaction between memory measure and information type, $F(1, 92) = 4.24$, partial $\eta^2 = .04$, $p < .05$, because although face-occupation associations were always better remembered than face-name associations, there was a bigger difference between names (M = 49%, SD = 22%) and occupations (M = 67%, SD = 16%) on the recall task $t(47) = 10.04$, $p < .01$, than between names (M = 73%, SD = 19%) and occupations (M = 87%, SD = 12%) on the recognition task, $t(47) = 7.82$, $p < .01$. The interactions between age and memory measure, and between age, information type, and memory measure were not significant, ps > .13. The impact of age, and the greater impact of age on memory for face-name versus face-occupation associations, was similar for the multiple-choice and recall experiments.

General Discussion

Older adults' disproportionate impairment in learning names in association with new faces has now been established using recall, matching, and multiple-choice memory measures. These findings allow us to rule out older adults' impaired ability to retrieve the phonology of the names as the cause of their specific difficulty evidenced on face-name association learning tasks. The obtained disproportionate age-related deficits in name learning using tasks tapping recognition of the association information (which do not require retrieval of the phonological form of the name from memory) implicates the associations between the face and the name as the primary locus of the age-related difficulty found on face-name learning tasks.

Several models of cognitive aging can explain older adults' general difficulty with new associations. The associative deficit hypothesis (ADH; Naveh-Benjamin, 2000) is a well-developed example, which posits that older adults' episodic memory deficits can be explained by their difficulty in forming new associations among individual pieces of information. In one test of the hypothesis, Naveh-Benjamin, et al. (2004) demonstrated that older adults have difficulty recognizing face-name pairings, and they were able to isolate the associative link as the primary source of the age-related deficit by showing that name recognition and face recognition had much smaller age declines than recognition of the paired items. As noted by Naveh-Benjamin and his colleagues, the idea that the formation of novel associations poses particular difficulty in older adults is not a new idea; Several authors had suggested similar (although possibly more limited) association-based accounts of age differences in previous work (e.g., Bayen et al., 2000; Chalfonte & Johnson, 1996; Mitchell et al., 2000).[2] However, none of these theoretical approaches have been developed to account for the specificity seen in our data: Associative deficits as described in these theories do not currently include mechanisms to explain why the association between a name and a face would be differentially more difficult for older adults to create and/or retrieve than the association between an occupation and a face.

The transmission deficit hypothesis (TDH; MacKay & Burke, 1990) of node structure theory (NST; MacKay, 1987) can explain both the age-related deficit in forming new associations (similar to that posited by the ADH), and also the disproportionate age-related impairment in associating proper names with faces. According to the TDH, priming spreads throughout an interactive-activation network that represents all of a person's knowledge. Adequate transmission of priming is critical to learning and memory, and aging is a factor that weakens the transmission of priming between all connections in the network, causing older adults to have difficulty in learning and remembering all new information[3]. Learning and retrieval of

[2]As pointed out by an anonymous reviewer, we cannot determine from our data whether older adults' deficit in new associations is due to a problem in the initial formation of the associations or due to rapid decay of newly-formed associations. It is possible that older adults form associations as often as young adults, but that older adults' connections are weak and quickly decay. This distinction does not differentiate the theoretical accounts of age-related changes in new associations addressed here.

[3]Priming in the transmission deficit model is a theoretical mechanism similar to spreading activation in other models (MacKay, 1987). Theoretical priming declines with age (MacKay & Burke, 1990) and is separable from priming as a behavioral effect, which is not systematically affected by age (e.g., Burke, MacKay, & James, 2000).

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proper names is *particularly* impacted in older adults because, within NST, names have single connections to the individuals they represent, whereas other types of words have multiple connections to aspects of their meaning. Within the architecture of the model, when there is only one connection to transmit priming, a deficit in that connection will devastate activation, whereas when there are many connections through which priming is transmitted to a node, a deficit in any one connection is unlikely to be devastating because sufficient priming can summate from the other connections.

Using the TDH framework, James (2004) suggested that older adults' difficulty with learning proper names for newly-encountered faces could reflect either a problem with encoding (forming and/or retrieving a new association between a face and a name) or with phonological retrieval (accessing and activating the relevant nodes to produce the sounds of the newly-associated name or occupation). When memory is tested via a recall task (as in the previous published studies testing for specific age-related deficits in face-name learning, e.g., Barresi et al., 1998; James, 2004; Rendell, et al., 2005), it is not possible to determine whether older adults' difficulty with proper names is due to a deficit in forming and/or retrieving face-name associations, a deficit in retrieving and producing the phonology of the names, or a combination of these two factors.

The present findings suggest refinement of James' (2004) interpretation of the TDH account of age-related changes in learning face-name associations. For these learning tasks, deficits in forming and/or retrieving the associations are primarily responsible for the obtained age differences. We do not, however, claim that retrieval problems play no role in other age-related difficulty with names. In different tasks involving names (e.g., name retrieval in response to celebrity pictures or descriptions), participants are simply instructed to recall well-known information, and older adults demonstrate pronounced difficulty in retrieving and producing names as opposed to other types of words, especially when TOT states are measured (e.g., Burke, et al., 1991; Evrard, 2002; James, 2006; Maylor, 1990; Rastle & Burke, 1996). Thus, even though proper name retrieval and production is disproportionately affected by aging in some tasks, phonological retrieval processes are not the primary source of older adults' difficulty in the current experiments. Because the pattern of age effects is the same for recall and recognition tasks, we know that the additional requirement of having to retrieve and produce the phonology of the name from memory (as opposed to merely recognizing the name) cannot account for the differential difficulty in face-name association learning experienced by older adults.

This research addresses empirical, theoretical, and practical questions concerning age-related changes in learning and memory for people's names. Results from the recognition tasks indicate that difficulty forming and/or retrieving new associations is the primary determinant of the age-related difficulty with proper name memory, adding empirically to a growing body of literature that is beginning to delineate areas of differential (rather than across-the-board) cognitive changes in older adulthood. The TDH model is one of few existing theories to have been specifically applied to the topic of learning and memory for names, and particularly to the effects of aging on proper name processing (e.g., Burke, Locantore, Austin, & Chae, 2004; Cohen & Burke, 1993; Cross & Burke, 2004; Fogler & James, 2007; James, 2004; James & Fogler, 2007). The present study helps to refine this theoretical account of name memory, particularly in terms of learning face-name associations. The findings also increase our understanding of a practical aspect of aging about which older adults frequently express concern, namely, their decreased ability to learn and remember names.

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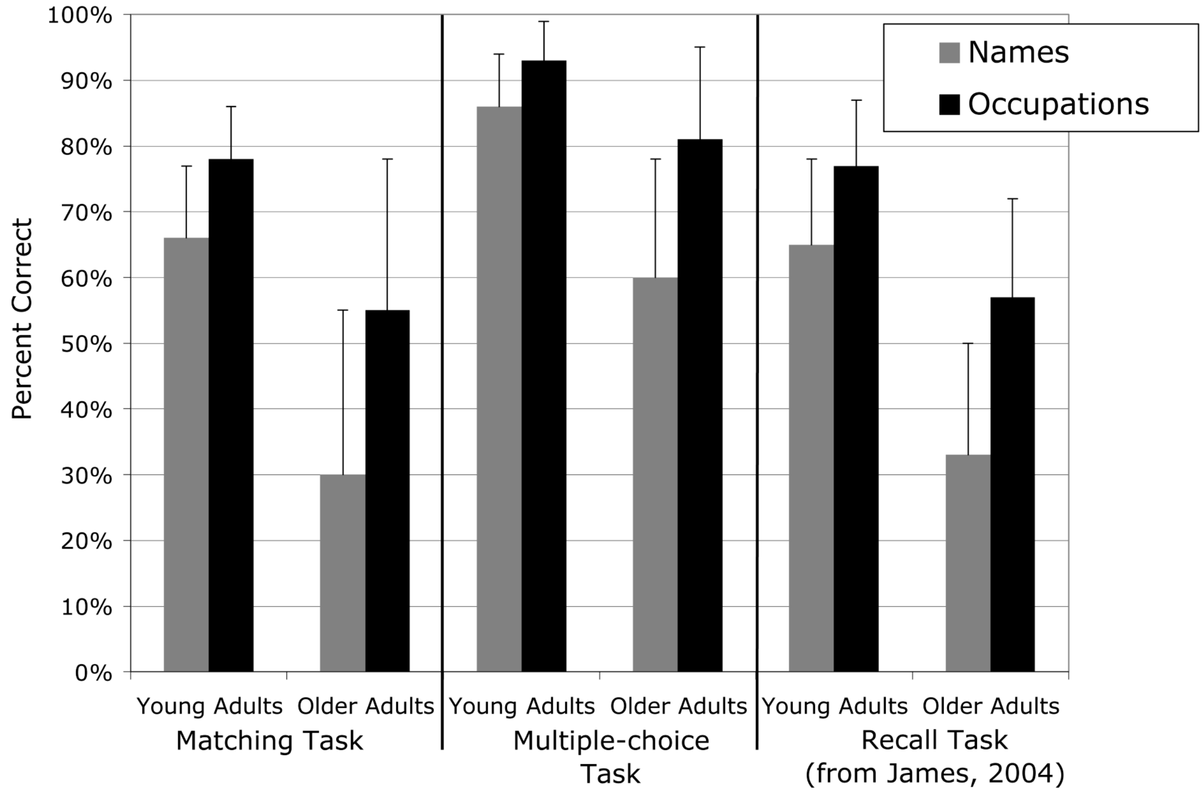

Figure 1.

Percentage of names and occupations correctly matched to the faces by young and older adults in Experiment 1 (left panel), correctly selected from the multiple-choice options presented beneath the faces in Experiment 2 (middle panel), and recalled in response to the faces by young and older adults in James (2004, Experiment 2; right panel). Error bars represent 1 SD.

Table 1

Mean Percentage of Presented faces (SD in parentheses) Resulting in Name Errors (Occupation Correctly Remembered but Not Name) and Occupation Errors (Name Correctly Remembered but Not Occupation) for Young and Older Adults in Experiments 1 and 2

	Error Type	
	Name Errors	**Occupation Errors**
Experiment 1		
Young adults	16% (11%)	4% (4%)
Older adults	27% (18%)	1% (1%)
Experiment 2		
Young adults	10% (8%)	4% (3%)
Older adults	26% (12%)	7% (6%)

Table 2

Mean Percentage Correct (SD in parentheses) for Names and Occupations for Young and Older Adults in the Initial Testing Round for Experiments 1 and 2

	Percent Correct	
	Names	**Occupations**
Experiment 1		
Young adults	19% (18%)	38% (22%)
Older adults	5% (8%)	19% (17%)
Experiment 2		
Young adults	70% (16%)	83% (14%)
Older adults	48% (18%)	72% (18%)