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Age Invariance in Semantic and Episodic Metamemory: Both Younger and Older Adults Provide Accurate Feeling of Knowing For Names of Faces

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Abstract

Age differences in feeling-of-knowing (FOK) accuracy were examined for both episodic memory and semantic memory. Younger and older adults either viewed pictures of famous faces (semantic memory) or associated nonfamous faces and names (episodic memory) and were tested on their memory for the name of the presented face. Participants viewed the faces again and made a FOK prediction about future recognition of the name associated with the presented face. Finally, four-alternative forced-choice recognition memory for the name, cued by the face, was tested and confidence judgments (CJs) were collected for each recognition response. Age differences were not obtained in semantic memory or the resolution of semantic FOKs, defined by within-person correlations of FOKs with recognition memory performance. Although age differences were obtained in level of episodic memory, there were no age differences in the resolution of episodic FOKs. FOKs for correctly recognized items correlated reliably with CJs for both types of materials, and did not differ by age group. The results indicate age invariance in monitoring of retrieval processes for name-face associations.

Keywords

Metamemory; Aging; Feeling-of-Knowing; Episodic Memory; Semantic; Memory

The effect of aging on memory varies according to the type of memory. Semantic memory--or memory for general knowledge--does not typically decline appreciably until old age (Balota, Dolan, & Duchek, 2000; Botwinick & Storandt, 1980; Lachman & Lachman, 1980; Laver & Burke, 1993). Conversely, episodic memory, or memory for new information (e.g., learning the name of a new acquaintance), typically is negatively impacted by aging (Hertzog & Shing, 2011; Hoyer & Verhaeghen, 2006; Kausler, 1994). Some scientists have argued for an increased age-related difficulty in forming new associations (e.g., Naveh-Benjamin, 2000) or in associating temporal context with specific information content (Howard, Jing, Rao, Provyn, & Datey, 2009), compared to retention of the content itself.

Deficits in associative binding and accessibility to associative information in memory are argued to be a central feature of changes in episodic memory during adulthood (Bender, Naveh-Benjamin, & Raz, 2010; Mitchell & Johnson, 2009; Shing, Werkle-Bergner, Brehmer, Müller, Li, & Lindenberger, 2010).

Aging may spare the accuracy of monitoring encoding in episodic memory tasks (e.g., Connor, Dunlosky, & Hertzog, 1997; Hertzog, Sinclair, & Dunlosky, 2010), even though memory itself is adversely affected by aging (Hertzog & Dunlosky, 2011). In this paper, we are concerned with the monitoring of search outcomes at retrieval during an associative memory task. We assessed the feeling of knowing (FOK); people predicted the likelihood of correct recognition of an item that was just tested by cued recall (e.g., Hart, 1967). Even when cued recall fails, FOKs demonstrate that evidence about whether the sought-after target is available in memory can in principle still be accessed, even if only through an intuitive sense or feeling that the target will be recognized (e.g., Koriat, 2000; Nelson, Gerler, & Narens, 1984). A different aspect of retrieval monitoring is evoked by asking individuals to rate their confidence in the accuracy of a retrieved response. Confidence judgments (CJs) have been widely used to study discrimination and bias in recognition memory from a signal detection perspective (e.g., McKensie, Wixted, Noelle, & Gyurjyan, 2001; Van Zandt, 2000), but they can also be used as a way of assessing the accuracy of performance and retrieval monitoring (Dunlosky & Metcalfe, 2009; Hines, Touron, & Hertzog, 2009). Both FOKs and CJs can be validated by assessing the within-person correlations (resolution) of those judgments with memory outcomes, such as recognition memory accuracy. To the extent that FOKs are accurate, then low FOKs should be associated with a lower probability of correct recognition more so than high FOKs. CJs and remember/know judgments (RKs) can also be used to validate FOKs (e.g., Souchay, Moulin, Clarys, Taconnat, & Isingrini, 2007). Indeed, these measures are particularly valuable because they can correlate with FOKs for correct recognition trials. Gradations of FOK within the class of correct recognitions cannot be evaluated by using recognition memory success as the basis for validation. FOKs predict the subsequent likelihood of recollective experiences, as measured by either CJs or RKs, during correct recognition trials (Hertzog, Dunlosky, & Sinclair, 2010; Hicks & Marsh, 2002; MacLaverly and Hertzog, 2009).

The existing research on the impact of aging on FOKs for episodic memories is inconclusive. Some studies have found that resolution of FOKs for newly learned associations is impaired with aging (e.g., Souchay et al., 2000; Souchay et al., 2007). For example, Thomas, Bulevich, and DuBois (2011) reported that remembering the emotional valence of unrecalled target words increased younger adults' FOK accuracy about future recognition of the targets, but that older adults were unlikely to use this information for FOKs unless the task context demanded that they do so. Even then, age differences in FOK resolution remained. These results are at odds with the repeatedly replicated age-related invariance in the resolution of semantic FOKs (e.g., Allen-Burge & Storandt, 2000; Bäckman & Karlsson, 1985; Butterfield, Nelson, & Peck, 1988; Lachman, Lachman, & Thronesbery, 1979; Marquié & Huet, 2000). The different FOK outcomes in semantic and episodic memory tasks have been used to argue for a specific age-related deficit in episodic, but not semantic FOKs (e.g., Souchay et al., 2007).

However, some recent studies have found age equivalence in FOK resolution for newly learned associations (Eakin & Hertzog, 2012; Hertzog, Dunlosky, & Sinclair, 2010; MacLaverly & Hertzog, 2009). For instance, Hertzog, Dunlosky and Sinclair (2010) found no age differences in FOK resolution when differential delays equated older and younger adults' memory performance. They also observed that manipulating the quality of original encoding influenced FOK resolution for both young and old adults. Their outcomes suggesting that age differences in episodic memory could influence age differences in FOK

accuracy (see Dunlosky & Metcalfe, 2009), although MacLaverly and Hertzog (2009) found no age differences in episodic FOK resolution despite reliable age differences in associative recognition memory performance.

Given that not all studies find age differences in episodic FOK resolution, a useful point of comparison regarding the episodic-semantic distinction in FOKs would be to compare semantic and episodic FOK resolution in the same experiment for the same individuals. However, given the differences in typical criterion tests for semantic FOKs (e.g., general knowledge questions) and episodic FOKs (e.g., verbal paired associates), it is rare to see direct comparisons of episodic and semantic FOK accuracy.

Souchay et al. (2007) explicitly compared metamemory for both semantic and episodic memory of both younger and older adults, comparing FOKs in the two tasks on different sets of participants. They measured semantic memory using 80 general-knowledge questions. For example, they asked participants in their semantic task to identify the subject of the painting “La Trahison” (the answer is PIPE). To measure episodic memory, they asked a different set of participants to memorize a set of weakly associated cue-target paired associates using the same targets (e.g., BIRTHDAY–PIPE). Thus the targets were identical in the semantic and episodic memory tests (e.g., PIPE) but the cues differed. Souchay et al. (2007) found no age deficit in FOK resolution for semantic memory; older adults’ FOKs were actually more accurate than younger adults. Conversely, older adults’ FOKs were less accurate than younger adults’ FOKs after episodic cued-recall failures.

Although Souchay et al.’s study was the first to test both semantic and episodic metamemory, there were still possible issues about comparability of the tasks. Most important, the cues on which people based their FOKs differed between the two memory types. For semantic memory, the cue was a general knowledge question that was necessarily and inherently linked to the target word; for episodic memory, the cue was a single word. Confounding both the method of cueing the FOK and strength of originally encoded cue-target relatedness with the type of memory test could have produced some of the age differences in FOK resolution between episodic and semantic tasks.

In the present study, we also tested FOKs for episodic and semantic memory in the same experiment to evaluate the pattern of age-related effects. We adopted a face-name associative task which equated the stimuli and method of cueing for semantic and episodic metamemory—a picture of a face cued metamemory and memory for both semantic and episodic memory—thus holding the cues constant across both memory types. For semantic memory, a famous face was presented for the recall, FOK, and recognition phases. Participants’ performance in a pre-experimental phase determined the likelihood of availability of the associated name in semantic memory. For episodic memory, a non-famous face was associated with a fictitious name that participants were asked to learn. The target response for both semantic and episodic memory was thus also held constant across the two memory types.

A pre-experimental phase was implemented in order to select famous persons to use as stimuli for each person’s test of semantic metamemory. This feature was intended to minimize the influence of level of prior semantic knowledge on semantic FOKs. In prior research on resolution of semantic FOKs, the “general” knowledge being tested was implicitly assumed to be available in all participants’ semantic memory. However, older adults may actually have more knowledge about the specific information being tested (e.g., Botwinick & Storandt, 1980), and may not show age differences in some measures of FOK accuracy for this reason. Furthermore, Beier and Ackerman (2001) found apparent cohort differences in knowledge of current events as a function of likely age of first exposure; one

might therefore anticipate age differences in prior exposure to faces of public figures that could influence semantic FOKs. To address these issues, we selected famous persons for semantic FOK stimuli separately for each participant. We used a preliminary session to present them with a corpus of famous faces for which they answered a series of questions, such as “What is this person famous for?” Each set of semantic stimuli for the FOK task was then tailored to each participant’s likely exposure to the famous person; to insure the variability needed for assessing FOK resolution we explicitly varied selected items with respect to variance in degree of participant’s accessed knowledge about the person (see Method section for details).

In addition to providing FOKs, participants also made CJs after answering each forced-choice associative recognition test question. CJs were used as a method of scaling degree of recollective experience during the recognition test (e.g., Rotello, Macmillan, Reeder, & Wong, 2005). Hicks and Marsh (2002) originally showed that FOKs for unrecalled items were correlated with recognition RK judgments. Hertzog, Dunlosky & Sinclair (2010) showed that FOKs for unrecalled items produced equivalent correlations with CJs for younger and older adults, suggesting a similar basis for gradations in FOKs for younger and older adults. This relationship has not previously been assessed for semantic FOKs. We therefore evaluated FOK-CJ correlations for both episodic and semantic FOKs in this study.

In summary, the present study examined FOK and CJ resolution in matching tests of episodic and semantic memory for face-name associations. We hypothesized that no age differences in metamemory monitoring accuracy would be observed for either episodic or semantic face-name associations using our procedures, even if it were the case that semantic FOK resolution was superior to episodic FOK resolution.

Method

Participants and Design

The young adult participants were 50 students (36 females and 14 males) enrolled at Mississippi State University who were reimbursed for participation with research credit. The mean age of young participants was 18.64 years ($SD = .79$) with a range of 18 to 21 (see Table 1). We recruited 56 older adults from databases of older-adult volunteers that are maintained by the Eakin Memory and Metamemory Lab ($n = 28$) and the Hertzog Adult Cognition Lab ($n = 28$). Three younger participants were excluded because their ages exceeded the criterion for inclusion in the young adult group. One older adult was excluded because they did not meet the MMSE minimum criterion score of 28. The mean age of participants was 72.23 years ($SD = 5.48$); older adults were financially reimbursed for their participation. The experiment design was a 2 (Memory Type: episodic, semantic) $\times$ 2 (Age: younger, older) mixed factorial design. Memory Type was manipulated within subjects and Age was a between-subjects factor. The presentation order of Memory Type was counterbalanced across participants; half participated in the episodic memory task first and half participated in the semantic memory task first.

Materials

Phase 1—The materials for Phase 1 consisted of 90 famous faces. (An additional 30 non-famous faces were also presented; these faces were the same used in Phase 2 of the study and are discussed fully in that section) A set of 480 non-copyrighted pictures of people from several professions, including actors, singers, political figures, and sports figures were acquired from the internet and used to determine a unique set of materials for testing metamemory for semantic memory. Any figures with easily identifiable names, such as Zsa Zsa, or single names, such as Madonna, were not allowed in the set due to constraints of

Phase 2 name selection for non-famous names. All pictures were edited to appear in grayscale and were placed on a white background. Pictures were cropped so that just the head and shoulders were visible. In addition, all background content was removed, as well as other distinguishing characteristics, such as words on a shirt. Eight different sets of 90 faces were created from the larger set. Initial sets of 90 faces were used because pilot testing suggested that exposure to no more than 90 faces was required in order to obtain a set of 30 famous faces that met the criterion for inclusion in the participant's semantic set. An equal number of male and female faces were selected for each set of 90 faces, and a variety of professions was represented in each set. Famous and nonfamous faces were mixed and randomly presented.

Five questions followed the presentation of each face: 1) Do you recognize this face? 2) What is this person's profession? 3) What is this person best known for? 4) What is one thing that would identify this person? 5) What is one other fact about this person? A separate database of potential correct responses to each question was generated for the entire set of famous faces.

Phase 2—The materials of Phase 2 consisted of 60 pictures: 30 famous faces and 30 non-famous faces. The 30 non-famous faces were obtained from the internet and were not copyrighted. The non-famous faces were edited in the same way as the famous faces; they were cropped, edited to grayscale, placed on a white background, and any distinguishing characteristics were removed. Each non-famous face was assigned a first and last name. The names were created by randomly recombining first and last names of famous faces (e.g., Ray Crosby). As mentioned, any figures with highly identifiable names (such as Zsa Zsa or Madonna) were not included in the corpus of famous faces in order to prevent problems with first name-last name repairing. An equal number of male and female faces were used.

The 30 famous faces used in Phase 2 were those that were chosen based on the accuracy of responses to the five questions asked about each face in Phase 1; therefore, the specific faces varied for each individual. The criterion for selection for each individual's subset was at least 40%, but no greater than 80% mean accuracy for the five questions from Phase 1 with an equal number of pictures receiving an accuracy score of 40%, 60% and 80% while maintaining an equal number of male and female faces. However, for some participants meeting this criterion was not possible; sometimes there were not enough faces in each of the accuracy conditions. For these participants, first the accuracy criterion and then the gender criterion was applied, and then any remaining faces from the 20% accuracy group were selected. If 30 faces still were not selected, then faces from the 0% accuracy group were selected, along with an equal number of 100% accuracy faces.

Additional materials—The Mini-Mental State Exam, MMSE (Cockrell & Folstein, 1988) was used to screen participants for impaired cognitive functioning during Phase 1. The MMSE asks questions about time and place orientation and has tests of working and long-term memory; the inclusion criterion score was greater than 27; the mean MMSE score for participants was 29.36 ($SD = 0.76$) and did not differ between age groups, $p > .05$. The Shipley Vocabulary test (Shipley, 1940) was also given to both groups; the mean Shipley scores for participants are reported in Table 1. Older adults scored significantly higher than younger adults, $t(104) = 7.28$, $p < .001$, a common finding in cognitive aging research. A demographic questionnaire included questions about age, gender, ethnicity, education and self-report of overall health (1 poor – 5 excellent). The older adults had 16 years of formal schooling on average, a higher education level than current undergraduate students; the older adults are similar to younger adults in terms of level of final educational attainment, who were on average between their first and second year of a college education. The two age groups did not differ on any other factor.

Procedure

Phase 1—After giving consent, participants sat one at a time in front of a desktop computer. They viewed the series of 120 pictures: 90 famous and 30 non-famous faces in random order (the particular set of 90 famous faces was randomly selected). Prior research has shown that seeing a cue multiple times during an experiment increases metamemory predictions due to familiarity (Metcalf, Schwartz, & Joaquim, 1993). Therefore, the 30 non-famous faces were intermixed with the famous faces to equate the number of times the faces in the two conditions would be seen prior to making FOK judgments about faces. Participants studied each face for a period of ten seconds. Then participants typed their answers to each of the five questions about the person depicted. Participants were told that they were not expected to know all the answers for all the pictures, to leave blanks where necessary, but not to guess. After completing the experiment, we administered the Mini-Mental State Exam (MMSE; Cockrell & Folstein, 1988) on an individual basis. Participants were reimbursed for their participation in Phase 1 and were given a reminder card about their appointment for Phase 2.

Phase I scoring procedure—Responses to each of the five questions were scored by two trained research assistants. Accuracy was determined by comparing responses to a key of all potential responses. If a plausible response was given that was not on the key, its accuracy was checked via a variety of internet sources. Accuracy scores were compared between the two research assistants and any discrepancies were resolved via discussion. Famous faces for which there were unresolved discrepancies were not included in the materials for that participant. After each question was scored, a composite accuracy score was created for each famous face in the participant's corpus of 90 faces. The original goal was to select famous faces following the criterion of an equal number receiving an accuracy score of 40%, 60% and 80%, while maintaining an equal number of male and female faces to serve as a unique stimuli set of famous faces for each participant. However, meeting this criterion was not always possible; not all participants achieved the accuracy criterion on a sufficient number of faces. For these participants, after the initial accuracy and then the gender criteria were applied, faces receiving 20% accuracy scores were selected first. If a complete set still was not achieved, an equal number of faces receiving 0% and 100% accuracy were selected to complete the semantic memory stimulus set.

The end result of Phase I was that the semantic set of pictures for 22 younger and seven older adults were successfully selected entirely from the 40–60–80% range, whereas the sets for 28 younger and 45 older adults were not selected entirely from the 40–60–80 range. Table 2 lists the mean distribution of face selection by accuracy and age group. A chi-square goodness-of-fit was performed to examine the whether meeting face-selection criteria differed between the two age groups. The difference was significant, $\chi^2(2, N = 106) = 51.84, p < .05$. Proportionately more younger than older adults met the criterion for face selection from the 40–80% range; however within-person variability was still achieved for both age groups.

Phase 2—One week after Phase 1, participants returned for Phase 2. First, either the episodic or semantic condition was presented on the computer, with the presentation order of both tasks counterbalanced. Stimuli were presented in random order within each condition. For the episodic condition, the set of 30 non-famous were presented for ten seconds during an encoding phase; each face was paired with one of the famous first name-last name re-pairings. Participants were instructed to remember the face-name pairing for a later test. After the encoding phase, each face was presented again, and participants were asked to recall the name associated with the face during the encoding phase. During the subsequent FOK prediction phase, each face was again presented and participants were

asked to predict whether they would be able to recognize the name of the face on a later multiple-choice test. Predictions were made using a scale of 0 (certain I will not recognize) to 100 (certain I will recognize). Following the FOK prediction phase, each face was presented again and participants were asked to select the name associated with the face from among three alternatives, one of which was correct. The alternatives consisted of names that had been paired with other faces during study. All responses were made on the keyboard. Participants also made CJs immediately after selecting their recognition response. The CJs used the same 0–100% confidence response scale as the FOKs. A filler task consisting of the Shipley Vocabulary test (Shipley, 1940) and the demographic questionnaire was presented between the two Memory Type conditions, regardless of which condition was first.

For the semantic condition, there was no encoding phase; the procedure started with the recall phase. Participants were shown the famous face and were asked to recall the name of the person depicted. Then, each famous face was shown again and participants provided their FOK prediction about later recognition for the name; a continuous scale of 0 to 100 was used. Finally, each famous face was presented again, along with their name and three alternatives (consisting of names of other famous faces in that participant's set), and CJs were collected. Participants selected the correct name and provided CJs by typing their responses on the keyboard.

Results

For analysis of mean differences in memory outcomes and metacognitive judgments, repeated-measures general linear model (GLM) was conducted. For analyses of resolution of metacognitive judgments using Goodman-Kruskal gamma correlations as dependent measures, we employed a mixed model analysis using the SPSS (Version 18.0) MIXED procedure to use all available data, despite some missing values (incomplete within-person data) due to noncomputable gamma correlations. In all statistical tests, the criterion for significance was set at $p < .05$.

Presentation order analysis—Probability of recall for the two memory types was submitted to a repeated measures Analysis of Variance (ANOVA) with the counterbalanced presentation order of Memory Type as the between-subjects factor. The main effect of presentation order was not significant, $p = .87$. All further analysis collapsed means across presentation order.

Recall

We first analyzed for cued recall of proper names (see Table 3 for means). The main effect of Age was not significant, $F < 1$; on average younger ($M = .23$, $SE = .01$) and older ($M = .22$, $SE = .01$) adults had similar levels of name recall. The main effect of Memory Type was significant, $F(1, 104) = 252.51$, $p < .001$. The effect size, when scaled in SD units (Cohen, 1988), was large in magnitude, $d = 1.00$. Recall was better for semantic ($M = .40$, $SE = .02$) than for episodic ($M = .07$, $SE = .01$) stimuli. The interaction between Age and Memory Type also was significant, $F(1, 104) = 9.20$, $p = .003$, $\eta^2 = .08$. A test of the simple effects showed a significant difference between the younger and older adults in episodic name recall, although recall was low for both age groups, $F(1, 80) = 21.96$, $p = .003$, $d = 1.22$. However, for semantic memory the simple effect test was not significant, $p > .05$, $d = .04$.

Recognition

As expected, the probability of recognition was higher than probability of recall, ($M = .75$ vs. $M = .23$), but still well below ceiling. The main effect of Age was significant, $F(1, 104) = 6.36$, $p = .01$, $d = .49$; recognition was somewhat higher for younger ($M = .78$, $SEM = .01$)

than for older ($M = .72$, $SEM = .01$) adults. The main effect of Memory Type was significant, $F(1, 104) = 290.87$, $p < .001$, $d = 1.74$; recognition was better for semantic ($M = .90$, $SE = .01$) than for episodic ($M = .60$, $SE = .02$) memory. However, a significant interaction between Age and Memory Type, $F(1, 104) = 21.55$, $p < .001$, $p^2 = .17$, demonstrated that although recognition in the semantic condition was similar for younger and older adults, older adults' recognition in the episodic condition was worse than that of the younger adults (see Table 3). This outcome conformed to expectations about the importance of the episodic/semantic distinction as related to age differences in name recognition.

Feeling-of-Knowing Predictions

Because analysis of FOK resolution typically focuses on unrecalled items, we focused on the effect of age and memory type on FOKs for unrecalled items alone¹. Because FOKs are typically correlated with recognition memory outcomes, the analysis included Recognition Accuracy (correct versus incorrect recognition decisions) as a factor.

The main effect of Age for unrecalled FOK predictions was not significant, $F < 1$, nor was the main effect of Memory Type, $F(1, 55) = 2.85$, $p = .10$. The interaction between Age and Memory Type was not significant, $F(1, 55) = 2.94$, $p = .10$. Recognition accuracy influenced FOKs, $F(1, 55) = 67.95$, $p < .001$, $d = .65$. FOKs were higher for recognized ($M = 41$, $SE = 2.59$) than for unrecognized ($M = 27$, $SE = 3.02$) items. Recognition accuracy interacted significantly with Memory Type, $F(1, 55) = 5.08$, $p = .03$, $p^2 = .08$. The difference between recognized and unrecognized names was greater for semantic ($D = 18$; $d = .65$) than for episodic ($D = 9$; $d = 0.42$) memory (see Table 4 for all means). The three-way interaction was not significant, $F < 1$.

Feeling-of-Knowing Resolution

Metamemory accuracy (or resolution) was calculated using the Goodman-Kruskal gamma correlation (G) to correlate FOK predictions with recognition outcomes. Feeling-of-knowing accuracy is most interesting for unrecalled items, when individuals cannot retrieve the target for which they are searching.² Table 5 reports the relevant mean G correlations across conditions. The mixed model analysis revealed that G correlations were reliably greater than a chance value of 0, $F(1, 94.52) = 182.24$, $p < .001$. There was no reliable main effect of Age, $F(1, 94.52) = 1.08$, $p = .30$. A trend for Memory Type, $F(1, 84.66) = 3.32$, $p = .07$ was associated with more accurate semantic FOKs ($M = .51$, $SE = .06$) than episodic FOKs ($M = .39$, $SE = .04$), $d = 0.23$. This pattern was obtained regardless of age; the interaction between memory type and age group was not significant, $F < 1$. These results were inconsistent with the hypothesis of an age-related deficit in episodic FOK resolution. Younger adults' resolution tended to be higher than older adults' resolution for semantic FOKs ($d = 0.23$), which is inconsistent with the hypothesis that semantic FOK resolution is spared in older adults, relative to episodic resolution³.

¹Information about FOKs for all items, whether recalled and unrecalled, is available in supplemental documents <given information>

²FOKs for all items were highly correlated with prior name recall success ($M = .89$, $SE = .02$), and did not vary by any experimental factor. See Eakin and Hertzog (2006, 2012) for similar results.

³Gamma correlations cannot be calculated when recognition accuracy is perfect. Eleven older adults who had 100% semantic recognition memory accuracy also gave nearly constant semantic FOKs of 100. If their Gs could have been calculated, they would likely have been high. Age differences in ceiling effects for semantic recognition memory may have contributed the trend for age differences in semantic FOK resolution.

Recognition Confidence Judgments

We were mainly interested in how recognition memory CJs can help validate FOKs and investigate age differences in FOK-by-CJ resolution. First, however, we report on age differences in the behavior of the CJs themselves.

Mean confidence judgments—The analysis of CJs paralleled that of FOKs, focusing on unrecalled items, and using Recognition Accuracy as a factor in the GLM. Overall, the main effect of age differences in CJs reflected age differences in recognition memory outcomes, $F(1,80) = 7.55, p = .007, d = 0.43$; younger adults ($M = 62, SE = 2.50$) were more confident than older adults ($M = 53, SE = 2.44$) in their recognition of unrecalled names. CJs also tracked the episodic-semantic distinction in recognition memory; confidence was significantly higher for semantic ($M = 64, SE = 2.11$) than episodic ($M = 52, SE = 2.16$) memory, $F(1,80) = 24.15, p < .001, d = .63$. In addition, Memory Type interacted significantly with Age, $F(1, 80) = 10.35, p = .002, p^2 = .12$. The difference in confidence between the semantic and episodic memory conditions was greater for the older ($D = 20$) than for the younger ($D = 4$) adults, reflecting the greater difference in confidence in semantic and episodic memory for the older than for the younger adults.

CJs were higher for recognized ($M = 75, SE = 1.59$) than unrecognized ($M = 40, SE = 2.28$) names; the main effect of recognition was significant, $F(1, 80) = 362.28, p < .001, d = 2.02$ and the three-way interaction with Memory Type and Age was significant, $F(1, 80) = 16.57, p < .001, p^2 = .17$. The pattern for CJs for younger and older adults was similar for episodic and semantic items for both recognized and unrecognized names; however, for the older adults, CJs were overall lower for both recognized and unrecognized episodic items (see Table 6).

Confidence judgment resolution: CJ by recognition—⁴Typically, CJs manifest high G correlations with recognition memory performance and in some instances differ in resolution between age groups. Overall, CJs were relatively accurate ($M = .58, SE = .04$) and did not vary with Age, $F < 1$, or Memory Type, $F(1, 80) = 1.68, p = .20, p^2 = .02$; the interaction was not significant, $F(1,80) = 1.83, p = .18, p^2 = .02$ (see Table 7 for means).

Confidence judgment resolution: CJ by FOK for unrecalled items—We first evaluated the CJ-FOK correlations for all unrecalled items, irrespective of whether they were correctly recognized, in a mixed model analysis. The overall G correlation ($M = .44, SE = .03$) was reliably greater than zero, $F(1, 100.53) = 280.54, p < .001$. The null hypothesis of age equivalence in CJ-FOK correlations seemed tenable (young: $M = .43, SE = .04$; old: $M = .45, SE = .04$), $F < 1, d = 0.07$. Likewise, there was no hint of an Age X Memory Type interaction, $F < 1$. There was a nonsignificant trend towards greater CJ-FOK correlations for episodic names ($M = .47, SE = .03$) relative to semantic names ($M = .40, SE = .05$), $F(1, 98.98) = 1.96, p = .17, d = .30$. Overall, then, variations in FOKs were reliably correlated with subsequent confidence in the accuracy of recognition memory decisions for semantic FOKs as well as episodic FOKs.

CJ by FOK correlations: By episodic name recognition—An interesting question is whether the aggregate CJ-FOK correlations are driven by variation in the higher or lower ends of the confidence range. In particular, CJ-FOK correlations for correctly recognized items most closely respond to the remember-know distinction highlighted by other investigators (e.g., Hicks & Marsh, 2002). G correlations among CJs and FOKs for episodic

⁴Although Pearson product-by-moment correlations are possible between FOKs and CJs, Goodman-Kruskal Gamma correlations were calculated for ease of comparison.

items were computed separately for correctly recognized names versus recognition errors (see Table 7). The analysis showed a reliable effect of recognition memory outcome, $F(1, 85.46) = 31.59, p < .001$, with higher resolution for correctly recognized names ($M = .52, SE = .03$) relative to incorrectly recognized names ($M = .17, SE = .05$), $d = 1.22$. There were no reliable effects of Age or the Age X recognition outcome interaction, both $F < 1$. As can be seen in Figure 1, the outcomes for the two age groups were virtually indistinguishable. It appears that gradations in FOK confidence after recall failure are most strongly related to the degree of recollective experience, as reflected in CJ variations for correctly recognized items.

CJ by FOK correlations for semantic items—A parallel analysis for semantic items yielded rather different results. Figure 2 shows the G correlations for recognized and unrecognized items (see also Table 7). As with episodic items, there was a reliable difference in CJ-FOK correlations between correct and incorrect semantic recognition trials, $F(1, 39.11) = 7.63, p = .009$, with better resolution for correctly recognized items ($M = .36, SE = .09$) than incorrect responses ($M = .01, SE = .10$). This difference was qualified by the reliable Age X recognition outcome interaction plainly evident in Figure 2, $F(1, 39.11) = 7.79, p = .008$. Whereas older adults tended to have a higher G correlation for correctly recognized items than younger adults, $d = -0.25$, older adults actually produced a negative correlation of CJs and FOKs for incorrectly recognized items ($d = 0.76$). This pattern seemed to be related to a tendency for older adults to transform lower confidence FOKs into high-confidence recognition errors when given alternative names, in all likelihood a consequence of high name familiarity for the incorrect lure.

Confidence judgment resolution: CJ by FOK for unrecalled, correctly recognized items—We conducted an additional analysis making an explicit comparison of episodic and semantic FOK resolution with respect to CJs for unrecalled but correctly recognized items (see Table 7). The mixed model analysis showed that the mean G correlation was well above chance ($M = .44, SE = .03$), $F(1, 92.17) = 200.34, p < .001$. Age had no aggregate impact on FOK-CJ resolution, $F < 1$. There was, however, a reliable difference between episodic and semantic G correlations, $F(1, 93.03) = 5.97, p = .016$, with higher resolution for episodic ($M = .53, SE = .05$) than for semantic ($M = .29, SE = .08$) items, $d = 0.53$, a medium-sized effect. Even though the cell means in Table 6 suggested age differences only for semantic FOK-CJ correlations (favoring older adults; $d = -0.30$) but not episodic FOK-CJ correlations ($d = 0.04$), the age X judgment type interaction was not reliable, $F(1, 93.03) = 1.26, p = .26$.

Discussion

Age-related declines in episodic memory in the presence of maintenance of semantic memory are considered classic findings in the field of cognitive aging (e.g., Botwinick & Storandt, 1980; see Kausler, 1994; Zacks, Hasher, & Li, 2000 for reviews). Our findings on memory performance were consistent with this classic pattern. In particular, consistent with prior research (e.g., James, 2004), learning new names of unfamiliar faces was quite difficult for the older adults in our study, a finding that is also consistent with a general age-related associative learning deficit (Old & Naveh-Benjamin, 2008). In contrast, older adults actually performed better than younger adults in recalling and recognizing famous faces pre-selected on the basis of likely exposure of the individual to the name, thereby insuring potential availability of the name in semantic memory. This identical pattern was observed for recall and for recognition memory.

These findings set us up to test the hypothesis that FOKs based on semantic memory are spared by aging, whereas age differences would be observed for episodic FOKs (e.g.,

Souchay et al., 2007). Our data reject this hypothesis. FOK resolution for episodic recognition memory success was essentially equivalent for the two age groups, with older adults giving higher FOKs being as likely to correctly recognize new names. Moreover, the predicted dissociation of age differences in episodic and semantic FOK resolution failed to materialize; if anything, older adults tended to be slightly less accurate on semantic rather than episodic items.

We also showed that older and younger adults had similar resolution of FOKs for correctly recognized items to retrospective CJs for those items, confirming that variations in FOKs are associated with the degree of recollective experience during the recognition test (e.g., Hicks & Marsh, 2002), and showing that this effect does not vary as a function of age (see also Hertzog, Sinclair, & Dunlosky, 2010). These findings are consistent with other studies indicating age invariance in semantic FOK resolution (e.g., Butterfield, Nelson, & Peck, 1988; Lachman, Lachman, & Thronesbery, 1979) yet inconsistent with a dissociation of age differences in episodic versus semantic FOK accuracy (e.g., Souchay et al., 2000, 2007).

We cannot at present explain the discrepancy between Souchay et al. (2007) and the present study. As we noted earlier, this study addressed some methodological issues that could have contributed to the differences in study outcomes. Our study used similar cues to test semantic and episodic memory, allowing for a more direct comparison between the two memory types. The use of older participants with lower cognitive functioning and lower education level could have also contributed to findings of less accurate metamemory for older adults in Souchay et al., 2000; 2007).

One possible critique of our semantic FOK task is that the use of proper names as targets brings age-related tip-of-the-tongue (TOT) deficits into play (e.g., James, 2004). Older adults are known to be vulnerable to lower proper name recall, which some have argued is produced by decreased spreading activation from semantics to phonology (Burke et al., 2004). TOT states for proper names involve phenomenal experiences of knowing the name but not being able to articulate it, and are accompanied both by access to partial information about the target name and high FOK. However, we claim that a greater propensity to name-retrieval failures due to phonological transmission deficits should benefit older adults' FOK accuracy. If memory has been accessed but naming is deficient, then high FOKs when an individual is in a TOT state should be correctly resolved at the time of recognition, elevating FOK correlations with recognition memory accuracy and CJs. Given that we did not find semantic FOK superiority for older adults, in contrast to Souchay et al. (2007), we do not think use of proper-name targets can explain the discrepancy between studies regarding semantic FOK resolution.

Arguably, the more pressing issue is our failure to detect age-related episodic FOK deficits. There are inconsistent results in the literature regarding episodic FOK resolution. Some studies have not detected any age deficits (Eakin & Hertzog, 2012; Hertzog, Dunlosky, & Sinclair, 2010; MacLaverly & Hertzog, 2009), but others have (Souchay et al., 2000, 2007; Thomas et al., 2011). It appears that a key explanatory variable may be the retrieval of relevant information about the unrecalled target or encoding context, often termed noncriterial recollection (e.g., Parks, 2007). Recent studies (Brewer, Marsh, Clark-Foos, & Meeks, 2010; Hertzog, Fulton, Sinclair, & Dunlosky, 2012; Thomas et al., 2011) have indicated that FOKs are influenced by retrieval of information about the target or the original encoding experience that also benefit FOK resolution. The noncriterial recollection account suggests that remembering aspects of the original study episode might generate higher FOKs than those generated in the absence of such recollective experiences, even in the absence of target recall itself. In turn, noncriterial recollection during cued recall may be correlated with the likelihood of a recollection experience when both the cue and target are

present in the recognition test. Recently, Hertzog and colleagues have shown that access at cued-recall to interactive mediators generated after experimenter instructions are strongly related to FOKs and recognition CJs (Hertzog, Fulton, Sinclair, & Dunlosky, in press).

Whether age differences are detected in FOK resolution may depend on whether experimental procedures generate sufficient noncriterial recollection for older adults to base FOKs on such recollection. The apparent discrepancy with Thomas et al. (2011) regarding episodic FOK resolution may then be due primarily to whether the retrieved details relevant to seeding the FOK are likely to be a routine—if not obligatory—basis for retrieval searches for the target. In the Thomas et al. study, the relevant cue was emotional valence of the target word, which older adults apparently were less likely to spontaneously access when making the FOK. They may be more likely to use noncriterial recollection to make FOKs when that recollection involves features of how the item was originally encoded, because searching for that information may be more likely during cued recall. It may also be the case that studies that did not detect age differences in episodic FOK resolution were less susceptible to influences that would inhibit or interfere with noncriterial recollection. Both Hertzog, Dunlosky, & Sinclair (2010) and MacLaverly and Hertzog (2009) used free-association norms to eliminate inter-item associations between cues and targets in their paired-associate stimuli, reducing the likelihood of between-item interference that might affect FOKs (e.g., Eakin, 2005).

How is this account relevant for the face-name FOKs used in the present study? The use of pictures of faces to test cued recall and elicit FOKs may be quite likely to lead to both familiarity and recollective experiences about the faces used as cues (see Hertzmann & Sommer, 2010), which in turn assists in the generation of accurate FOKs. Older adults might be able to use facial cue familiarity (e.g., Hosey, Peynircio lu, & Rabinovitz, 2009) or facial distinctiveness (e.g., Watier & Collin, 2012) to assist in generating accurate FOKs. In the Hosey et al. study, young adults made both episodic (Exps. 2 & 3) and semantic (Exp. 1) FOKs for face-name associations, cueing name recall with either a famous face (semantic FOK) or a recently studied face (episodic FOK). FOKs were more accurate for semantic than for episodic memory, and were accompanied by higher levels of initial name recall and correct name recognition for semantic faces. Their participants often reported using the familiarity of faces as the basis for their FOK judgment, although accessibility to information about the target was often reported as well. Watier and Collin (2012) showed that FOKs were based on the distinctiveness of faces; not only did distinctive faces benefit associative memory for a name over indistinct faces, FOKs were also higher for distinctive faces. Older adults may do relatively well when making FOKs on the basis of distinctive stimuli such as faces (but see Watier & Collin, 2011, who found better FOK accuracy for young adults with noun-noun pairs than for face-name pairs).

From this perspective then, the accumulating evidence indicates that age differences in episodic FOK resolution will vary according to other variables that have not yet been fully understood. Instead of focusing on whether there is or isn't an age-related episodic FOK deficit, the field should start exploring the task conditions and processing requirements that can elicit deficits, versus those that promote age-equivalence. In short, which variables moderate age differences in episodic FOK resolution? In any case, we argue that our present results are difficult to reconcile with a claim that episodic FOK accuracy is generically impaired, whereas semantic FOK accuracy is preserved.

Indeed, one aspect of the semantic FOK results reported here suggests a possible age difference that merits further attention in future research. Older adults had higher FOK-CJ correlations for correct recognition responses but actually generated reliable *negative* correlations for recognition memory errors. This pattern suggests the presence of high-

confidence recognition memory errors for our semantic face-name stimuli by older adults. When presented with familiar names and a familiar face in the forced-choice semantic recognition memory test, older adults may have been more likely to interpret the joint familiarity of both stimuli as indicative of the correct face-name pairing. To the extent that misrecollections are specifically elicited by the recognition test stimuli, but not during FOK generation, the combination of low FOKs and high CJs for some recognition memory errors could produce negative FOK-CJ correlations. Older adults are known to be more prone to such misrecollections in certain types of episodic recognition memory tests (e.g., Dodson, Bawa, & Krueger, 2007; Shing et al., 2010). There is no parallel literature to our knowledge involving aging and high-confidence errors with facts or world knowledge. The effect may be most evident when the stimuli were selected, as in this study, to be ones where individuals were likely to have encountered both faces and names in the past. In such cases, older adults may be more likely to be lured by familiar names, despite the use of a forced-choice recognition test designed to reduce responding on the basis of item familiarity per se (Patterson & Hertzog, 2010).

Certainly, further research on the specific origins of the high-confidence semantic recognition memory errors generated in our paradigm seems warranted by these unexpected results.

Limitations and Future Directions

A key feature of the present study was the attempt to uniquely identify relevant semantic information for each participant by testing exposure to events (i.e., movies, television shows) in which the target character had appeared. However, we did not fully achieve our objective of equating all persons on degree of likely availability of semantic information; the criteria established for inclusion in the semantic item set were not met by all participants. One way future studies might better approximate this goal could be to select a separate corpus of pictures for the younger and older adults that better match generational differences in likelihood of exposure to the famous personalities. Another issue with the current study is that episodic recall was low for both age groups. This factor was not particularly problematic for this study because participants were predicting recognition in the absence of recall. However, the episodic and semantic versions of the task were not equal in difficulty.

Conclusion

The older adults in this study manifested no deficit in episodic FOK resolution, and did not show superior resolution of semantic FOKs over episodic FOKs. These results therefore falsify the hypothesis that episodic memory retrieval failures are a source of special difficulty in metacognitive monitoring for older adults (see Hertzog & Dunlosky, 2011). Although deficits in metamemory accuracy might be obtained in older adults who are declining in other areas of cognition, such as executive functioning (e.g., Perrotin, Tournelle, & Isingrini, 2008), or in older adults who are less well educated than their comparison young adult group, age does not appear to invariably impact the accuracy of retrieval monitoring in healthy, high-functioning older adults.

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Figure 1.
Mean gamma correlations between confidence judgments and feeling-of-knowing judgments for episodic memory: unrecalled, recognized versus unrecognized faces.

Figure 2. Mean gamma correlations between confidence judgments and feeling-of-knowing judgments for semantic memory: unrecalled, recognized versus unrecognized faces.

Table 1

MMSE, Shipley Scores, and Demographic Information

Filler Task	Age Group			
	Younger Adults (n= 50)		Older Adults (n = 28)	
	M	SD	M	SD
MMSE	29.06	1.71	29.36	0.86
Shipley Acc.	0.69	0.14	0.86	0.09
Demographic				
Age	18.64	0.79	72.23	5.48
Education (years)	13.19	0.79	16.09	2.70
Overall Health	4.02	0.77	3.85	0.85

Table 2

Mean Distribution of Face Selection from Phase 1 by Accuracy and Age Group

Accuracy	Age Group			
	Younger Adults (<i>n</i> = 50)		Older Adults (<i>n</i> = 56)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
0%	.62	2.15	1.20	2.77
20%	.96	1.83	1.95	2.93
40%	5.90	3.91	5.05	3.46
60%	8.40	4.13	7.66	3.90
80%	10.60	5.23	10.07	4.25
100%	3.52	6.25	4.07	5.51

Table 3
Mean Probability of Recall and Recognition by Age Group and Memory Type

Memory Type	Age Group			
	Younger Adults		Older Adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Recall				
Episodic	.10	.01	.03	.04
Semantic	.36	.20	.41	.20
<i>M</i>	.23		.22	
Recognition				
Episodic	.67	.15	.49	.18
Semantic	.89	.12	.92	.09
<i>M</i>	.78		.72	

Table 4
Mean Feeling of Knowing (FOK) Prediction by Age Group for Unrecalled Items

Memory Type	Recognition Accuracy	Age Group			
		Younger Adults		Older Adults	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Episodic	Recognized	39.29	22.05	32.16	21.51
	Unrecognized	27.69	20.91	25.92	18.72
	<i>M</i>	33.49	29.04		
Semantic	Recognized	42.34	19.10	50.11	28.40
	Unrecognized	24.45	22.94	31.02	40.37
	<i>M</i>	33.39	40.56		

Table 5

Feeling of Knowing (FOK) Accuracy for Recognition of Unrecalled Items

FOK by Recognition (Unrecalled Only)	Age Group			
	Younger Adults		Older Adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Episodic	.39	.32	.38	.40
Semantic	.56	.40	.46	.57

Note: The values indicate mean Goodman-Kruskal intraindividual gamma correlations

Table 6
Mean Confidence Judgments for Unrecalled items by Memory Type and Age Group

Memory Type	Recognition Accuracy	Age Group					
		Younger Adults			Older Adults		
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Episodic	Recognized	80	3.23	53	3.15	67	
	Unrecognized	41	3.63	32	3.55	37	
	<i>M</i>	60		42			
Semantic	Recognized	82	2.69	85	2.62	83	
	Unrecognized	47	4.35	41	4.25	44	
	<i>M</i>	64		63			

Table 7

Mean Gamma Correlations for Confidence Judgments

Gamma Type	Memory Type	Recognition Accuracy	Age Group					
			Younger Adults			Older Adults		
			M	SD	M	SD	M	SD
CI × Recognition	Episodic		0.61	0.26	0.46	0.29		
	Semantic		0.61	0.56	0.63	0.62		
CI × FOK	Episodic	Recognized	0.53	0.50	0.51	0.48	0.52	
		Unrecognized	0.16	0.79	0.19	0.74	0.18	
	Semantic	Recognized	0.30	0.79	0.42	0.75	0.36	
		Unrecognized	0.30	1.64	-0.28	1.82	0.01	