Psychology and Aging
1995, Vol. 10, No. 4, 507-517

0882-7974/95/$3.00

Aging and Single Versus Multiple Cues in Source Monitoring

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Participants heard words said by 2 speakers and later decided who said each word. The authors varied the perceptual distinctiveness of the speakers and the distinctiveness of the cognitive operations participants performed on the words. Relative to younger adults, older adults had significantly lower source monitoring scores when perceptual or cognitive operations conditions were similar but not when either cue was more distinctive. Combining cues did not affect source monitoring of younger adults but hurt older adults' performance relative to the distinctive perceptual condition. Evidently, older adults generate cognitive cues at the expense of encoding perceptual cues; any deficit in binding perceptual and semantic information disadvantages them more in source monitoring than in old/new recognition. There was no correlation between neuropsychological tests assessing frontal function and source monitoring in older adults.

The ability to identify the source of remembered information is a fundamental cognitive function. For example, it is critical for distinguishing fact from fantasy in autobiographical memories, evaluating the reasonableness of our opinions and beliefs, and monitoring which of our intended actions have and have not occurred. Making attributions about the origin of memories is referred to as source monitoring (Hashtroudi, Johnson, & Chrosniak, 1989; Johnson, 1988; Johnson, Hashtroudi, & Lindsay, 1993). A number of studies have recently focused on source monitoring deficits associated with aging (Cohen & Faulkner, 1989; Dywan & Jacoby, 1990; Ferguson, Hashtroudi, & Johnson, 1992; Hashtroudi et al., 1989; Hashtroudi, Johnson, Vnek, & Ferguson, 1994; McIntyre & Craik, 1987; Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991). Older adults have been found to perform more poorly than young adults on a number of different source monitoring tasks.

For example, McIntyre and Craik (1987) exposed younger and older adults to real and made-up facts. When asked to recall the source of these facts, older adults had difficulty remembering whether a fact was learned during the experiment or if it originated from another source, as well as difficulty remembering presentation modality (auditory vs. visual) of information learned during the experiment. Older adults also had difficulty remembering which of two people said a word or whether they themselves thought of a word or said it aloud (Hashtroudi et al., 1989). In addition, older adults were more likely than younger adults to say that imagined actions had been watched and that watched actions had been performed (Cohen & Faulkner, 1989).

Although there is considerable evidence that there are age differences in source monitoring across a wide variety of situations, the mechanisms responsible for age differences in source monitoring are less clear (Ferguson et al., 1992; Hashtroudi et al., 1994). To investigate this issue, we have been using a framework specifically developed to understand the processes involved in remembering the source of information and that account for source misattributions (Johnson et al., 1993). According to this framework, all source monitoring decisions depend on the memory characteristics being evaluated and the type of judgment processes engaged. Regardless of how a memory comes about, information about the event's perceptual (e.g., sound and color), spatial–temporal, semantic, and affective properties may be represented as well as information about the cognitive operations (e.g., organizing and elaborating) that took place at the time. Many source monitoring decisions are made in a rapid, nondeliberative manner, capitalizing on differences in average values for these characteristics between memories from different sources. For example, externally derived memories generally have more perceptual and contextual information, semantic details, and information concerning emotional reactions. Memories originating internally have more available information about the cognitive operations that were involved in generating the memory. Therefore, memories with large amounts of visual and spatial information, but very little information about cognitive operations, should be attributed to an external source. Conversely, memories with large amounts of information about cognitive operations and little visual detail should be attributed to an internal source (Johnson & Raye, 1981).

In addition to such nondeliberative, heuristic processes, some source monitoring decisions involve more systematic reflection (e.g., Johnson, 1988; Johnson & Hirst, 1993). Individuals may recall information in addition to that specific to an event memory,

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Shahin Hashtroudi died February 24, 1992.

A portion of this article was presented at the annual meeting of the Eastern Psychological Association, Arlington, Virginia, April 1993. This research was supported by National Institute on Aging Grant AG09253. We would like to thank Lina Alathari and Jennifer Grinnell for their help in conducting the experiments and Theresa Gleason and Carol Reisen for their help in analyzing the data. We also thank the members of the 1993–1994 Princeton Cognition Lab and Fergus Craik and Larry Jacoby for comments on a draft of this article.

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or reason about a memory's likely source based on additional knowledge they have, beliefs about how memory works, what others are like, and so forth (Johnson, 1991; Johnson et al., 1993). Thus, one may correctly attribute a vivid memory of a conversation with Eleanor Roosevelt to imagination on the basis of the knowledge that she died before one's birth. Because source monitoring relies both on the quality of the memory characteristics and the reflective processes involved, there are several ways source monitoring might be disrupted. For example, one or more of the various memory characteristics may not be available or may not be distinctive, inappropriate criteria might be applied, or an individual may fail to engage in useful reasoning process and retrieval of previous related knowledge.

With respect to the first possibility (i.e., reduced availability of source-specifying attributes), a growing body of evidence suggests that older adults have difficulty in remembering certain aspects of events (Burke & Light, 1981). Evidence of age-related deficits in source monitoring is provided by a number of studies that have shown age-related decrements in remembering perceptual aspects (Kausler & Puckett, 1980, 1981), spatial–temporal attributes (Kausler, Lichty, & Davies, 1985; Light & Zelinski, 1983; Moore, Richards, & Hood, 1984; Park, Puglisi, & Lutz, 1982; Perlmutter, Metzger, Nezworski, & Miller, 1981; Pezdek, 1983), and semantic detail of presented information (Craik & Simon, 1980; Hess, 1984; Rabinowitz & Ackerman, 1982; Rabinowitz, Craik, & Ackerman, 1982). Given that source monitoring depends on these memory characteristics, age differences in the accessibility of such information should lead to age differences in the accuracy of source monitoring.

In an earlier study motivated by the source monitoring framework, Hashtroudi et al. (1989) compared younger and older adults in two source monitoring tasks: discriminating between memories for words they heard two other people say and discriminating between words they heard another person say and words they said themselves. Compared with younger adults, older adults had more difficulty in the first case, suggesting that when decisions about source rely on memory for specific perceptual information, such as appearance and voice quality of two people, performance is disrupted in older adults. Conversely, in the second case, in which the presence or absence of one's own cognitive operations is an important cue for source, older adults performed as well as younger adults (see also Rabinowitz, 1989). Although this experiment was not designed to isolate and ascertain the relative importance of various memory characteristics in age differences in remembering source, it did suggest that older adults have the most trouble in conditions in which perceptual information is particularly important.

In a second study (Hashtroudi, Johnson, & Chrosniak, 1990), we directly assessed age-related differences in various memory characteristics. Individuals both participated and imagined participating in various activities (e.g., having coffee and cookies). In subsequently recalling the events, older adults reported less spatial and perceptual information. In addition, older adults had lower performance than younger adults in a source monitoring test given 3 weeks later that required them to discriminate actual from imagined events. On the basis of these findings and the theoretical framework we are using (Johnson et al., 1993), we suggested that age-related source monitoring difficulties may be related to older adults' difficulty encoding perceptual information. Consistent with this notion that older adults have difficulty encoding subtle perceptual cues, age-related deficits in identifying which of two female assistants said particular words was eliminated when one speaker was a woman and one a man (Ferguson et al., 1992).

Together, these studies indicate that source monitoring deficits in older adults can be traced at least in part to deficits in encoding or retrieval of perceptual information. They also suggest that older individuals may have less of a deficit (or none) in using cognitive operations information as a cue to source. However, no strong conclusions can be reached about the relative effectiveness or salience of different types of cues because they were not directly compared in any of the previous studies.

Experiment 1

This experiment directly explores the relative contribution of perceptual cues and cognitive operations information to age-related deficits in discriminating memories from different external sources (external source monitoring). The logic involved first identifying changes in perceptual cues that would produce the same level of improvement as changes in cognitive operations cues for younger adults. The primary question was whether, under these circumstances, older adults also show equal benefits from increasing the distinctiveness of perceptual or cognitive cues or whether they show greater benefit from one or the other cue. In short, to compare two types of memory characteristics, we systematically varied their distinctiveness and looked for a differential impact of this manipulation on the source monitoring accuracy of young and older adults.

We used the external source monitoring paradigm from Hashtroudi et al. (1989) and Ferguson et al. (1992). Participants first heard words spoken by two assistants. A surprise memory test followed in which the presented items were intermixed with new items, and individuals were asked to indicate for each item which of the two assistants said it or if the item was new. In Experiment 1 we explored the role of perceptual information in source monitoring tasks by varying the physical similarity of the two assistants (two women vs. a man and a woman). We also examined the role of cognitive operations as a cue to source by contrasting a condition in which the individual performed the same orienting task on words spoken by both assistants with a condition in which different orienting tasks were performed on words spoken by each of the two speakers (in these conditions, perceptual cues were similar). A fifth condition assessed the relative effectiveness of two cues for source monitoring by combining the distinctive perceptual and distinctive cognitive operations conditions. Finally, a sixth condition examined the effectiveness of three cues by combining distinctive perceptual, cognitive, and spatial information.

There were two main questions of interest. First, given that the conditions were selected so that young adults would be equally helped by increasing the distinctiveness of perceptual or cognitive cues, would older adults also derive equal benefit from distinctive perceptual or cognitive cues? Second, would both age groups be affected equally by increasing the number of distinctive cues? Older adults might require more cues to achieve the same level of source monitoring achieved by younger adults with single cues. On the other hand, introducing more stimulus features may increase the difficulty of encoding a stimulus event, thereby reducing the probability that any particular feature is effectively encoded by older adults.

A third question had to do with the relation of source monitoring to frontal lobe functions. There is evidence suggesting that frontal lobe dysfunction may produce deficits in source monitoring (Johnson et al., 1993). Some studies of brain-damaged patients find impaired memory for the source of trivia facts, and the source monitoring accuracy seems to be related to measures of frontal lobe dysfunction (Schacter, Harbluk, & McLachlan, 1984; Janowsky, Shimamura, & Squire, 1989). Additional evidence from both physiological and behavioral studies indicate that the frontal cortex is particularly sensitive to the effects of aging (Albert & Kaplan, 1980; Woodruff, 1982). On the basis of these findings, McIntyre and Craik (1987) posited that age deficits in source monitoring may be associated with frontal lobe dysfunction. In support of this idea, Craik, Morris, Morris, and Loewen (1990) reported correlations between source monitoring scores and performance on two neuropsychological tests thought to reflect frontal function, the Wisconsin Card Sorting Test and Benton Verbal Fluency Test. Therefore, we obtained scores on these two tests for our participants and looked for correlations with source monitoring scores in Experiment 1.

Method

Participants. Ninety-six younger adults (41 men and 55 women) and 96 older adults (37 men and 59 women) participated in this experiment. The younger adults were undergraduate and graduate students at The George Washington University who received course credit or payment for their participation. The older adults were community residents from the Washington, D.C., area who were solicited through advertisements and received payment for their participation. All participants reported themselves to be in good health and were apparently free from sensory difficulties or had corrected vision or hearing, or both. The mean age of the younger adults was 20 years (range = 18–27 years), and the mean age of the older adults was 70 years (range = 65–76).

The mean number of years of education was 14.48 years ($SD = 1.12$) for the younger adults and 15.82 years ($SD = 2.58$) for the older adults. A 2 × 6 analysis of variance (ANOVA) on years of education, with age and source monitoring conditions as variables, revealed that there was a main effect of age, $F(1, 178) = 21.75$, $MSE = 4.00$, but no main effect of condition, $F(5, 178) = 1.01$, and no significant interaction between age and condition ($F < 1$). Older adults were more educated than younger adults; however, years of education did not differ across experimental conditions.

All the participants completed the Vocabulary subscale of the Wechsler Adult Intelligence Scale—Revised (WAIS–R; Wechsler, 1981). The mean scores were 54.9 ($SD = 4.9$) for the younger adults and 60.7 ($SD = 5.3$) for the older adults. A 2 × 6 ANOVA with age and source monitoring conditions as variables showed that older adults had higher WAIS–R scores, $F(1, 180) = 69.93$, $MSE = 25.86$. There was no main effect of condition, $F(5, 180) = 1.43$, and no significant interaction between the variables, $F(5, 180) = 1.06$. Although the WAIS–R scores were higher for older adults, they were not different across the experimental conditions.

Design. At acquisition, all participants viewed a videotape. Two assistants (either a man and a woman or 2 women) appeared on the television screen. A third experimenter did not appear on screen; however, her voice was heard. Female assistants were chosen on the basis of similarity in appearance. Both women spoke with a similar tone and accent, and their style and color of dress were comparable. The male and female assistants were chosen to maximize differences in physical characteristics and voice tones (a young African American woman and an older Caucasian man). In all conditions participants were instructed to pay careful attention to the items as they were presented by the two assistants.

Four conditions comprised a 2 (age: young vs. older adult) × 2 (type of cue: perceptual vs. cognitive) × 2 (distinctiveness of cue: same or different) independent groups design. These four conditions were as follows: in the perceptual same condition (FF), there were two female assistants; in the perceptual different condition (MF), one assistant was female and one was male; in the cognitive operations same condition (FFCOS), both assistants were female and participants were instructed to rate, on a 5-point scale, the pleasantness of each word as it was presented by the assistants (e.g., 1 = *unpleasant,* 5 = *pleasant*); in the cognitive operations different conditions (FFCOD), participants were required to rate the pleasantness of the word if one female assistant said the word and to decide if they liked the word if the other female assistant said the word (e.g., *Do you like the word? Yes–No*). On the basis of our pilot work, we expected that increasing the distinctiveness of perceptual (FF vs. MF) cues would have approximately the same magnitude of effect as increasing the distinctiveness of cognitive cues (FFCOS vs. FFCOD) for young adults. The planned 2 × 2 × 2 ANOVA allowed us to evaluate, relative to the young adults, potential differential effects of increasing the distinctiveness of perceptual compared with cognitive cues for older adults.

We included two additional conditions that, in combination with the MF condition, allowed us to assess the effects of increasing the number of distinctive cues from one to two or three. In the perceptual and cognitive operations different condition (MFCOD), one assistant was female and one was male, and participants were required to perform different orienting tasks for words presented by each assistant (see cognitive operations different condition [FFCOD]). In the five conditions described so far, the two assistants appeared on the screen seated next to each other in front of a plain blue curtain facing the participant (camera). To avoid providing a consistent spatial cue, the video was created so that halfway through the acquisition list the two assistants reversed positions. In the sixth condition, a potential spatial cue was introduced by having the two assistants maintain distinctive and consistent locations. The two assistants sat at opposite ends of a stage, with one assistant seated in front of a potted plant and the second assistant in front of a colorful print.[1] In this condition (MFCODSP), the two assistants were perceptually and spatially quite different, and participants were instructed to perform different cognitive operations on words spoken by each. Planned comparisons of the MFCOD and the MFCODSP conditions with the MF condition were conducted to evaluate the consequences of increasing the number of distinctive cues.

Sixteen participants in each age group were tested in each condition: perceptual same (FF), perceptual different (MF), cognitive operations same (FFCOS), cognitive operations different (FFCOD), perceptual and cognitive operations different (MFCOD), and perceptual, cognitive operations, and spatial different (MFCODSP). Extensive piloting with young adults preceded the choice of cognitive operations to ensure that the increase in source monitoring accuracy derived from increasing distinctiveness of cognitive operations (FFCOS vs. FFCOD) was equated with the increase in source monitoring accuracy due to increasing the distinctiveness of perceptual cues (FF vs. MF). These individuals did not participate in Experiment 1.

[1] Clearly, more was varied in this condition than the distance between the speakers. However, space is partly a matter of relative position of objects (such as of a person to a plant) in the environment. Our intention was to introduce distinctiveness in the spatial locations of speakers, not to sort out particular aspects of spatial information such as distance between two target objects versus their relation to other objects.

Materials. The materials consisted of 52 words from various grammatical classes with frequencies of 30–40 occurrences per million (Thorndike & Lorge, 1944). Twenty-six of the words were randomly assigned to each of two sets. Both sets served equally often as target and distractor items across participants. Thirteen words from the target list were assigned to each of two assistants. To illustrate, in the perceptual different (MF) condition, 13 words were assigned to the female assistant, and 13 words were assigned to the male assistant. Across participants, each target item appeared equally often in each of the six conditions.

Words were placed on the presentation list randomly with the restriction that no more than two words would be presented by one assistant successively. For the source monitoring test, the 26 target words and the 26 distractor words were randomly distributed with the following restrictions: Places at the beginning and end of the test list were not filled by words that appeared first or last on the study list, and no two words appeared adjacently on both the study list and test list.

The Benton Facial Recognition Test (Benton, de S. Hamsher, Varney, & Spreen, 1983), the Benton Verbal Fluency Test (Benton, 1968), the Vocabulary and Block Design subscale of the WAIS–R (Wechsler, 1981), and the Wisconsin Card Sorting Test (Heaton, 1981) were also administered.

Procedure. Each participant was tested individually; within age group, they were randomly assigned to conditions. All participants ($N = 192$) completed a personal information questionnaire concerning current occupation, education, and general health. Each individual then heard an acquisition list, followed by an identification of source test and the WAIS–R Vocabulary test. A subset of the sample ($N = 110$, 57 younger and 53 older adults) returned for a second session and was administered the neuropsychological tests.

The videotaped acquisition list was presented at 5 s per item. All words were spoken in a loud, clear fashion to ensure that older adults would have no difficulty hearing them. Participants were seated near the center of a rectangular table, with the television and VCR resting on the table top approximately 1½ ft from them.

In all conditions each word was heard only once. The off-camera voice called one of the on-screen assistants by name and then held up a cue card with one of the target items for them to read. The cue card was not visible on the screen. Participants were told that the first assistant would be asked to say some words aloud and the second assistant would be asked to say other words aloud. All individuals were told that the purpose of the experiment was to provide control data from adults to compare with a study designed for children. Participants were not informed of the memory test. To familiarize them with the procedure, six practice trials preceded the acquisition phase.

In all of the conditions, the initial position (left or right) of the first female or the male assistant and the cognitive operation performed on presentation of a word by an assistant were counterbalanced across participants.

Following the acquisition phase, a source monitoring test was presented. Participants received a booklet containing 52 words and were asked to identify which of the two assistants said each word by circling their name, or *new* if the word was not recognized. The source monitoring test was self-paced, and no participant required more than 5 min to complete it. After the test phase, participants were given the WAIS–R Vocabulary test.

On the second day, participants were given several standard neuropsychological tests in the following order: the Wisconsin Card Sorting Test, the Benton Facial Recognition Test (short form), the Block Design subtest of the WAIS–R, and the Benton Verbal Fluency Test.

Results and Discussion

Source monitoring scores. To obtain source monitoring scores, for each individual the total number of words attributed to the correct source was divided by the total number of words correctly identified as old. To illustrate, in the perceptual different condition (MF), the source monitoring scores refer to the number of words correctly attributed to the male assistant plus the total number of words correctly attributed to the female assistant, divided by the total number of words correctly identified as old. The significance level was set at .05 for all statistical analyses reported in this article, unless otherwise specified.[2]

To examine whether there were any differences between the two acquisition lists, a 2 × 6 × 2 (Age × Source Monitoring Condition × List) ANOVA was conducted. There was no main effect of list, $F(1, 168) = 1.99$, $MSE = 0.01$, and list did not interact with age ($F < 1$) or condition, $F(5, 168) = 1.40$; nor was there a significant three-way interaction ($F < 1$). Therefore, the data were collapsed across the two lists throughout this article (see Table 1).

The first set of analyses explored the consequences of increasing the distinctiveness of a single perceptual or cognitive cue and included the first four conditions in Table 1. A 2 × 2 × 2 ANOVA, with age, type of cue (perceptual vs. cognitive), and distinctiveness of cue (similar vs. different) as variables, was conducted on these conditions. There were significant main effects of age, $F(1, 120) = 14.72$, $MSE = 0.01$; type of cue, $F(1, 120) = 21.08$; and distinctiveness of cue, $F(1, 120) = 63.26$, and a significant interaction between age and distinctiveness of cue, $F(1, 120) = 4.14$. Neither the interaction between age and type of cue nor the three-way interaction were significant ($Fs < 1$). Subsequent analyses revealed that the performance of both younger adults, $F(1, 60) = 19.58$, $MSE = 0.01$, and older adults, $F(1, 60) = 45.13$, $MSE = 0.01$, increased when perceptual or cognitive cues became more distinctive. The Age × Distinctiveness interaction indicates that older adults benefited more than the younger adults from the change from similar to different cues (20% for older adults vs. 12% for younger adults). Consistent with our pilot data, younger adults profited equally from the change from the same to distinctive cues in the perceptual and cognitive conditions. Older adults showed the same pattern: They also profited equally from increasing perceptual or cognitive distinctiveness (i.e., MF–FF = FFCOD–FFCOS).

As can be seen in Table 1, performance of both younger and older adults was quite good with distinctive perceptual cues (MF). An additional set of planned comparisons explored the consequences for each age group of adding distinctive cues to the MF condition. Relative to a distinctive perceptual cue,

[2] The source monitoring and recognition data were analyzed as reported later and also using the multinomial modeling technique described by Batchelder and Riefer (1990), with a software package by Xiagnen Hu (1990). Briefly, the multinomial approach permits one to derive separate estimates of discrimination (both old–new and A–B source discrimination) from an analysis of the frequencies with which responses (e.g., Person A, Person B, and New) are given to items from each category (Person A, Person B, and New). Of the several models described by Batchelder and Riefer, we used Model 4. The results were comparable for both types of analyses; the more familiar analyses are reported here to permit comparisons with published data from related earlier work (Hashtroudi et al., 1989; Ferguson et al., 1992). A summary of the multinomial analysis may be obtained from Marcia K. Johnson.

Table 1
Mean Proportion of Items Called Old *and Also Attributed to the Correct Source in Experiment 1*

Source monitoring condition	Younger adults		Older adults	
	M	*SD*	*M*	*SD*
Perceptual same (FF)	.74	.16	.63	.15
Perceptual different (MF)	.85	.07	.84	.08
Cognitive same (FFCOS)	.66	.07	.54	.12
Cognitive different (FFCOD)	.79	.10	.73	.10
Perceptual–cognitive different (MFCOD)	.86	.12	.75	.11
Perceptual–cognitive different & spatial (MFCODSP)	.86	.10	.76	.12

Note. FF = 2 female speakers; MF = Male and female speakers; COS = same cognitive judgement for words said by both speakers; COD = different cognitive operation for words said by speaker A and speaker B; SP = spatial speakers in distinctive spatial locations.

younger adults' performance was not affected by the presence of multiple cues ($Fs < 1$). That is, performance was not affected when cognitive cues were added to perceptual cues (MFCOD) or when both cognitive and spatial cues were added to perceptual cues (MFCODSP). Older adults also showed no benefits from additional cues. In fact, addition of cognitive cues (MFCOD), $F(1, 30) = 7.15$, $MSE = 0.01$, or both cognitive and spatial cues (MFCODSP), $F(1, 30) = 5.14$, significantly reduced performance in older adults from that found in the condition with one salient perceptual cue.

Contrary to what was expected on the basis of previous studies, older adults did not show a greater deficit in using perceptual as compared with cognitive operations information. When perceptual and cognitive cues were equated in effectiveness for younger adults, they were also equal in effectiveness for older adults. That is, MF–FF = FFCOD–FFCOS for younger adults and MF–FF = FFCOD–FFCOS for older adults as well. The comparison of one versus multiple cues yielded an intriguing pattern. Younger adults' performance was not enhanced by multiple cues, suggesting that younger adults use the single most diagnostic cue for a source monitoring condition. In contrast, older adults' performance actually declined if additional potential cues were introduced.

Old–new recognition. Recognition scores refer to the participants' ability to discriminate old items (words presented during acquisition) from new items (distractors) without regard for correct identification of source. Table 2 shows the proportion of hits, false positives (new items mistakenly attributed to one of the two assistants), corrected recognition scores (hits minus false positives), and d′ scores.

Analyses of recognition scores were similar to those for source monitoring scores. First, a 2 × 2 × 2 ANOVA on d′ scores in the first four conditions in Table 2 with age, type of cue, and cue distinctiveness as variables yielded significant main effects of age, $F(1, 120) = 4.43$, $MSE = 0.58$; cue type, $F(1, 120) = 34.39$; and cue distinctiveness, $F(1, 120) = 3.88$; and a significant interaction between age and type of cue, $F(1, 120) = 10.63$. The corrected recognition measure analysis revealed a significant main effect of age, $F(1, 120) = 7.09$, $MSE = 0.02$; cue type, $F(1, 120) = 24.52$; and a significant interaction between age and type of cue, $F(1, 120) = 7.30$. Overall, recognition scores were higher in younger adults. Recognition performance decreased when cue distinctiveness was increased. The interaction reflects the fact that older adults performed as well as younger adults in the perceptual conditions, but they performed significantly worse than young adults in the cognitive operations conditions.

As shown in Table 2, relative to one distinctive perceptual cue (MF), younger adults' recognition performance increased when a distinctive cognitive cue was added (MFCOD): For d' scores, $F(1, 30) = 17.46$, $MSE = 0.73$; for corrected recognition scores, $F(1, 30) = 18.15$, $MSE = 0.02$. Older adults' recognition scores did not benefit from the presence of two distinctive cues (MFCOD): d' scores, $F(1, 30) = 3.63$, $MSE = 0.49$; corrected recognition scores, $F(1, 30) = 1.73$, $MSE = 0.02$.

Recognition performance in the condition with three distinctive

Table 2
Recognition Performance of Younger and Older Adults in Experiment 1

Source monitoring condition	Younger adults		Older adults	
	M	*SD*	*M*	*SD*
Perceptual same (FF)				
Hits	.88	.07	.84	.12
False positives	.13	.13	.12	.19
d′	2.61	.81	2.76	.90
Corrected	.74	.14	.72	.19
Perceptual different (MF)				
Hits	.82	.12	.82	.16
False positives	.12	.12	.09	.11
d′	2.48	.93	2.65	.67
Corrected	.71	.17	.74	.16
Cognitive same (FFCOS)				
Hits	.95	.04	.87	.14
False positives	.00	.01	.06	.09
d′	4.03	.42	3.21	.75
Corrected	.95	.04	.81	.13
Cognitive different (FFCOD)				
Hits	.92	.05	.79	.13
False positives	.03	.06	.03	.04
d′	3.52	.67	2.90	.84
Corrected	.89	.08	.76	.15
Perceptual–cognitive different (MFCOD)				
Hits	.93	.06	.83	.12
False positives	.02	.04	.02	.05
d′	3.74	.76	3.12	.73
Corrected	.91	.08	.80	.12
Perceptual–cognitive different and spatial (MFCODSP)				
Hits	.93	.06	.89	.08
False positives	.04	.05	.02	.04
d′	3.56	.58	3.27	.62
Corrected	.89	.06	.87	.09

Note. MF = Male and female speakers; FF = 2 female speakers; COS = same cognitive judgement for words said by both speakers; COD = different cognitive operations for words said by speaker A and speaker B; SP = spatial speakers in distinctive spatial locations.

cues, when compared with that with one distinctive perceptual cue, improved in younger adults: for d' scores, $F(1, 30) = 15.47$, $MSE = 0.61$; for corrected recognition, $F(1, 30) = 16.64$, $MSE = 0.02$. For older adults, there was also an increase in both d' scores, $F(1, 30) = 7.46$, $MSE = 0.41$, and corrected recognition scores, $F(1, 30) = 8.13$, $MSE = 0.02$, with three distinctive cues.

Compared with two cues, three cues did not significantly affect either d' scores or corrected recognition for either younger adults (Fs < 1) or older adults: for d' scores, $F < 1$; for corrected recognition, $F(1, 30) = 2.92$, $MSE = 0.01$.

It is noteworthy that recognition performance was unrelated to source monitoring performance. Increasing the distinctiveness of a single cue enhanced source monitoring performance in both age groups but seemed to have an opposite effect on recognition performance. When compared with a single distinctive perceptual cue, younger adults' source monitoring performance did not benefit from the presence of multiple cues, whereas older adults' performance declined. Both age groups, however, increased recognition performance with two or three cues compared with one cue.

Correlations of recognition and source memory with neuropsychological tests. The correlations among various response measures are shown in Table 3. For the young adults, there was a significant positive correlation between the WAIS-R Vocabulary subtest and recognition performance (d' scores: $r = .27$, $p < .01$; corrected recognition: $r = .30$, $p < .01$). There was also a positive correlation between the Benton Facial Recognition Test and correct source identification in younger adults ($r = .42$, $p < .01$).

For the older adults, old–new recognition measures were positively correlated with the Vocabulary subtest of the WAIS-R (d' scores: $r = .35$, $p < .001$; corrected recognition: $r = .32$, $p < .01$), Benton Facial Recognition Test (corrected recognition: $r = .31$, $p < .05$), and the number of categories achieved on the Wisconsin Card Sorting Test (d' scores: $r = .34$, $p < .05$; corrected recognition: $r = .30$, $p < .05$). For older adults, none of the neuropsychological tests correlated with source monitoring.

Craik et al. (1990) reported a correlation for older adults between source monitoring scores and the Wisconsin Card Sorting and Benton Verbal Fluency tests, whereas we did not. Such differences in outcomes may reflect differences in the participant populations studied or, perhaps more likely, differences in the source monitoring situations investigated. As Johnson et al. (1993) emphasized, there are various types of source monitoring situations involving a range of memorial characteristics and cognitive processes and probably involving other brain regions in addition to the frontal lobes (e.g., hippocampal or diencephalic). Given the lack of specificity of what standard neuropsychological "frontal tasks" actually measure (e.g., they are not always correlated with each other), and the complexity of source monitoring, one should perhaps not be surprised that correlations between source monitoring accuracy and frontal tests vary across studies with populations (e.g., older adults and amnesics) in which frontal and other brain regions might be impaired. A more systematic study of the relation between damage in specific brain regions and performance on a range of source monitoring tasks is needed.

Experiment 2

From Table 1, it appears that older adults derived almost no benefit from distinctive perceptual cues when they engaged in a different orienting task for the words spoken by each assistant ($.73_{FFCOD}$ vs. $.75_{MFCOD}$). This finding is especially striking because our studies consistently show that older adults benefit greatly from increasing the perceptual distinctiveness of the speakers (Ferguson et al., 1992; the FF vs. MF conditions in our

Table 3
Intercorrelations Among Response Measures

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
				Younger adults						
1. Source	0.79	0.13	—							
2. *d'*	3.32	0.91	0.12	—						
3. Corrected recognition	0.85	0.14	0.12	.96***	—					
4. WAIS-R Vocabulary	54.92	4.93	0.00	.27**	.30**	—				
5. WAIS-R Block	36.72	8.77	0.02	−0.09	−0.09	0.12	—			
6. Benton Facial Recognition	23.15	1.76	.42**	−0.06	−0.04	−0.04	−0.05	—		
7. Benton Verbal Fluency	43.03	9.33	−0.12	−0.07	−0.08	0.06	0.1	0.05	—	
8. Wisconsin Card Sorting	5.45	1.08	0.08	0.00	−0.02	−0.20	0.16	0.15	−0.03	—
				Older adults						
1. Source	0.71	0.15	—							
2. *d'*	2.98	0.77	0.05	—						
3. Corrected recognition	0.78	0.15	0.09	.91***	—					
4. WAIS-R Vocabulary	60.74	5.30	−0.03	.35***	.32**	—				
5. WAIS-R Block	26.96	7.67	0.08	0.17	0.20	.32*	—			
6. Benton Facial Recognition	22.51	2.28	0.10	0.24	.31*	.38**	0.20	—		
7. Benton Verbal Fluency	44.19	10.83	0.06	0.21	0.19	0.13	.31*	0.24	—	
8. Wisconsin Card Sorting	4.66	2.01	0.16	.34*	.30*	0.17	.29*	0.07	.29*	—

Note. WAIS-R = Wechsler Adult Intelligence Scale—Revised.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Experiment 1). One possibility is that keeping track of which cognitive task to perform for each word represents a complex task involving the coordination of two agendas (e.g., Johnson & Reeder, in press) and may be especially demanding for older individuals. Alternatively, even if switching cognitive tasks were not required, simply having to perform an orienting task for each item may be demanding and reduce older adults' processing of perceptual detail. Experiment 2 explores this second possibility. Three conditions were included: MF and FFCOS (replicating the corresponding conditions from Experiment 1) and MFCOS (a new condition). If engaging in any cognitive task distracts older adults from encoding or using perceptual information, then older adults should show no (or less) benefit than young adults from increasing the distinctiveness of perceptual cues (FFCOS vs. MFCOS). On the other hand, if there is something especially disruptive about the COD task, then older adults may benefit from increases in perceptual distinctiveness with the COS task. A comparison of the MF and MFCOS conditions provides information about the effects of adding a cognitive task to a distinctive perceptual situation.

Method

Participants. Forty-eight younger and 48 older adults participated in this experiment. The younger and older participants were recruited in the same way as in Experiment 1; however, none of the individuals had participated in that experiment. The mean age of the younger adults was 20.5 years (range = 18–22 years), and the mean age of the older adults was 71.1 years (range = 64–80 years).

The mean number of years of education was 15.1 (SD = .9) for the younger adults and 16.2 (SD = 2.7) for the older adults. For the WAIS–R Vocabulary subscale, the mean scores were 55.1 (SD = 7.3) for the younger adults and 61.4 (SD = 5.0) for the older adults. Two separate 2 × 3 ANOVAs (with age and source monitoring conditions as variables) were conducted on the WAIS–R scores and years of education. These data showed that the older adults were more educated, $F(1, 90) = 8.33$, $MSE = 3.65$, but there was no main effect of condition, $F(2, 90) = 2.41$. There was a significant interaction between age and condition, $F(2, 90) = 3.80$. Subsequent analyses revealed that older adults in the FFCOS condition (M = 17.50) achieved significantly higher levels of formal education than those in the MFCOS condition (M = 15.25), $F(1, 30) = 7.45$, $MSE = 5.43$, and that older adults in the FFCOS condition were significantly more educated than the younger adults in the FFCOS condition (M = 15.00), $F(1, 90) = 13.71$, $MSE = 3.65$. These differences do not, however, account for the pattern of source monitoring scores to be reported later. Older adults had higher WAIS–R scores, $F(1, 85) = 23.18$, $MSE = 39.24$; however, there was no main effect of condition and no interaction between age and condition (both $Fs < 1$). Although the WAIS–R scores were higher for the older adults, they were not different across the experimental conditions.

Design and materials. Sixteen younger and 16 older adults were tested in each of three source monitoring conditions: perceptual different (MF), cognitive operations same (FFCOS), and perceptual different and cognitive operations same (MFCOS). The study and test materials were identical to those in Experiment 1. As described earlier, two sets of planned comparisons were of interest: MF versus MFCOS and FFCOS versus MFCOS.

Procedure. Each participant was tested individually; within each age group, participants were randomly assigned to conditions. All participants completed a personal information questionnaire. Each then heard an acquisition list, followed by an identification of source test and the WAIS–R test.

At acquisition, each participant viewed a videotape where two assistants appeared on the screen seated next to each other, facing the participant (camera). Halfway through the acquisition list the two assistants switched positions. Both the perceptual different (MF) and cognitive operations same (FFCOS) conditions were identical to the MF and FFCOS conditions in Experiment 1. In the perceptual different and cognitive operations same conditions (MFCOS), one assistant was female and one was male. Half of the participants were required to rate on a 5-point scale the pleasantness of each word as it was presented, and half were required to determine if they liked the word. The initial position of the first assistant was counterbalanced across participants.

All other aspects of the procedure were the same as in Experiment 1.

Results and Discussion

Source monitoring scores. The source monitoring scores were obtained in the same way as in Experiment 1 and are shown in Table 4. The first set of analyses examined the similarities in performance between the perceptual different condition (MF) and the cognitive operations same condition (FFCOS) in this experiment with the MF and FFCOS conditions in Experiment 1. The source monitoring performance of both younger and older adults in the MF condition of Experiment 1 was identical (.85 and .84) to their performance in the current experiment (.85 and .84) (both $Fs < 1$). In the FFCOS condition, the performance of both younger and older adults was very similar in this experiment (.65 and .52) and in Experiment 1 (.66 and .54; both $Fs < 1$). Thus the replication was remarkably close for both age groups and both conditions.

Focusing now on the MF and MFCOS conditions from Experiment 2, what were the consequences of adding a single cognitive orienting task (MFCOS) to the MF condition? There was a main effect of age, $F(1, 60) = 3.90$, $MSE = .01$, and a main effect of condition, $F(1, 60) = 17.42$; younger adults were more accurate and overall performance was poorer in the MFCOS than the MF condition. Although the interaction between age and condition, $F(1, 60) = 2.19$, $p < .14$, was not significant in planned analyses of each age group separately younger adults' performance was not significantly affected by the addition of the COS task, $F(1, 30) = 2.40$, $MSE = .02$, whereas older adults' performance significantly declined with the addition of the COS task, $F(1, 30) = 32.94$, $MSE = .01$.

A second set of analyses compared the FFCOS and MFCOS conditions in Experiment 2. There was a main effect of age, $F(1, 60) = 12.26$, $MSE = .02$, and a main effect of condition, $F(1, 60) = 17.92$. The interaction between age and condition was not significant ($F < 1$). Generally, scores were higher for younger adults. Planned comparisons between the FFCOS and the MFCOS conditions for each age group separately revealed that performance of younger adults, $F(1, 30) = 5.10$, $MSE = .02$, as well as of older adults, $F(1, 30) = 17.24$, $MSE = .01$, was significantly higher in the MFCOS than the FFCOS condition.

Thus, the primary finding from Experiment 2 was that when participants engaged in the same orienting task for all words, older adults profited as much as young adults when the distinctiveness of the speakers was increased (FFCOS vs. MFCOS). By inference, then, these results suggest that the absence of any difference in monitoring accuracy of the older adults in the FFCOD and MFCOD conditions in Experiment 1 was a consequence of the added complexity of the COD task relative to the COS task.

Table 4
Mean Proportion of Items Called Old *and Also Attributed to the Correct Source in Experiment 2*

Source monitoring condition	Younger adults *M*	Younger adults *SD*	Older adults *M*	Older adults *SD*
Perceptual different (MF)	.85	.12	.84	.08
Cognitive same (FFCOS)	.65	.15	.52	.13
Perceptual different and cognitive same (MFCOS)	.77	.16	.68	.08

Note. MF = Male and female speakers; FF = 2 female speakers; COS = same cognitive judgement for words said by both speakers.

Old–new recognition. The results of the old–new recognition are shown in Table 5. We conducted a 2 × 2 ANOVA on d' scores and corrected recognition measures in the MF condition from Experiment 1 and the same measures in the MF condition from Experiment 2, with age and experiment as factors. The results showed no significant main effect of age (both $Fs < 1$), no main effect of experiment (both $Fs < 1$), and no interaction between age and experiment: for d' scores, $F(1, 60) = 1.04$, $MSE = .77$; for corrected recognition measures, $F < 1$.

Similar analyses on the FFCOS conditions from Experiment 1 and Experiment 2 on d' scores and corrected recognition measures revealed a significant main effect of age: for d' scores, $F(1, 60) = 14.63$, $MSE = .53$; for corrected recognition, $F(1, 60) = 20.31$, $MSE = .01$; but there was no significant main effect of experiment and no interaction between age and experiment (all $Fs < 1$). In both conditions, recognition scores were higher in young than in older adults. These results indicate that both the MF and FFCOS conditions from this experiment replicated the findings from Experiment 1.

When the MF and MFCOS conditions from Experiment 2 were compared, there was a main effect of condition for both corrected recognition, $F(1, 60) = 26.96$, $MSE = .02$, and d', $F(1, 60) = 32.31$, $MSE = .61$; adding the COS task improved recognition. The main effect of age was almost significant in the d' analysis, $F(1, 60) = 3.77$, $p < .06$, with older adults having somewhat lower recognition. The Age × Condition interaction was not significant for either measure ($Fs < 1$). When the FFCOS and MFCOS conditions were compared, recognition scores were higher for young than for older adults for both corrected recognition, $F(1, 60) = 12.33$, $MSE = .01$, and d', $F(1, 60) = 8.54$, $MSE = .52$. Neither the main effect of condition nor the Age × Condition interaction were significant for either measure ($Fs < 1$).

In short, increasing the distinctiveness of the speakers (FFCOS vs. MFCOS) increased source monitoring accuracy for both age groups, whereas it did not affect old–new recognition for either age group (although it should be noted that recognition performance of the young adults was near ceiling in these two conditions). Adding the cognitive operation requirement to the MF condition (MF vs. MFCOS) reduced the accuracy of source monitoring (particularly for the older adults), but it substantially helped participants' old–new recognition performance. Overall, these results suggest that the absence of any benefit for older adults in Experiment 1 from distinctive perceptual cues when FFCOD and MFCOD were compared cannot be attributed simply to having a cognitive task requirement. Rather, it appears that older adults are able to engage in a single cognitive task and still derive substantial benefit from perceptual distinctiveness of two speakers. When, however, the complexity of the cognitive task is increased, they no longer benefit from perceptual distinctiveness. Note that participants must be attending to differences between the two speakers in a general way as they perform the COD orienting task, which requires a different response depending on the speaker. Evidently, for older adults, the COD task is complex enough to attenuate the processing that ordinarily goes beyond simply discriminating between individuals and that helps bind perceptual features of the speakers to the words spoken (e.g., Chalfonte & Johnson, 1993, in press).

General Discussion

These experiments explored factors affecting old–new recognition and external source monitoring of words spoken by two individuals. We varied the perceptual similarity of the speakers (2 women or a man and a woman) and the similarity of the cognitive operations (same or different) performed by the participants on the words said by the two speakers. On the basis of pilot work, we selected conditions such that increasing the distinctiveness of perceptual cues and of cognitive cues would produce equivalent beneficial effects for younger adults. This allowed us to assess the potential differential impact of perceptual and cognitive cues on older adults. We found that although older adults' source monitoring performance was lower than younger adults' in the nondistinctive cue conditions, older

Table 5
Recognition Performance of Younger and Older Adults in Experiment 2

Source monitoring condition	Younger adults *M*	Younger adults *SD*	Older adults *M*	Older adults *SD*
Perceptual different (MF)				
Hits	.90	.07	.84	.12
False positives	.14	.15	.11	.09
d'	2.78	.98	2.50	.89
Corrected	.76	.17	.73	.16
Cognitive same (FFCOS)				
Hits	.97	.03	.90	.12
False positives	.02	.03	.05	.11
d'	4.09	.64	3.51	1.00
Corrected	.96	.05	.85	.15
Perceptual different and cognitive same (MFCOS)				
Hits	.97	.04	.90	.08
False positives	.02	.05	.02	.03
d'	3.99	.56	3.51	.61
Corrected	.94	.06	.88	.08

Note. MF = Male and female speakers; FF = 2 female speakers; COS = same cognitive judgement for words said by both speakers.

adults profited substantially and equally when either type of cue, perceptual or cognitive, was made distinct. In fact, under single distinctive perceptual cue conditions (MF), older adults performed as well as younger adults on the source monitoring task. These results clearly do not support the idea that older adults have more difficulty using perceptual than cognitive operations information as cues to source.

Next, consider the issue of multiple cues. As can be seen in Table 1, this study replicated the Ferguson et al. (1992) result showing that older adults performed as well as young adults in the distinctive perceptual cue (MF) condition. This allowed us to compare other conditions to this one and ask if older and younger adults are equally hurt or helped by adding additional distinctive cues. Compared with the MF condition, introducing additional cognitive or cognitive and spatial cues (MFCOD and MFCODSP) had no effect on the performance of young adults but substantially hurt performance for older adults. These results suggest that in using perceptual information, older adults can perform as well as younger adults under ideal conditions (i.e., distinctive perceptual cues), but they suffer under less than ideal conditions, when distinctive cues of both types are combined (MFCOD).

Note that the distinctive perceptual cue condition in these experiments could, itself, be thought of as a combined cue condition in that the two speakers differed in a number of ways (e.g., age, race, gender, clothing, and voice). Perhaps both young and older adults used only one of these perceptual cues, or perhaps some of these cues can be relatively easily combined. Whether older adults show deficits only in some but not all feature combinations remains to be explored (e.g., Chalfonte & Johnson, in press).

Experiment 2 explored whether just any additional cognitive load could account for the age-related deficit in the multiple cue conditions. In Experiment 2, when participants were required to perform the same cognitive operations on words said by both speakers, older adults benefited at least as much as did younger adults when perceptual distinctiveness of the speakers was added (FFCOS vs. MFCOS). This rules out the possibility that performing *any* cognitive task produces such a cognitive load on older adults that they cannot process perceptual information. Thus, the fact that any benefit of distinctive perceptual cues seems to be eliminated for older adults when they perform the COD task suggests that they may be unable to effectively process the perceptual information while they are keeping track of which cognitive operation they are to perform on each item. The orienting task assures that they attend to each item and make a differential response depending on the speaker; therefore, the results cannot be attributed to a general failure to attend to the speakers.

One interpretation of our results can be derived from the Multiple-Entry, Modular Memory system (MEM) proposed by Johnson and colleagues (Johnson, 1992; Johnson & Chalfonte, 1994; Johnson & Hirst, 1993). Prominent models of aging propose that age-related deficits in memory result from global changes in brain function such as reduced processing capacity or resources or a general slowing of processes (e.g., Craik & Simon, 1980; Hasher & Zacks, 1979; see Salthouse, 1991, for a review). MEM provides a way of specifying such global changes in terms of component cognitive processes. According to MEM, information about speaker qualities (voice, expression, gender, physical characteristics, etc.) is bound to item information and consolidated through reflective component cognitive processes such as noting, refreshing, rehearsing, and reactivating, which are controlled by task agendas (Johnson, 1992; Johnson & Chalfonte, 1994; Johnson et al., 1993; Johnson & Hirst, 1993). In the MF condition, both age groups presumably are able to engage in such reflective activity, and the resulting bound information is available for source monitoring judgments. Evidently, in the COD conditions, older adults are less able than younger adults to successfully carry out processes that promote binding of perceptual information to semantic information (perceptual information that will be useful later in source monitoring) at the same time they are engaged in processes necessary to perform this more complex cognitive task. Such binding processes would include noting, refreshing, rehearsing, and reactivating perceptual aspects such as the tone of voice, pronounciation, the facial expression, and so forth, of the speakers as they say particular words. These are reflective component processes that go beyond initial perceptual processing (e.g., Johnson, 1992). (For additional evidence that older adults may have binding deficits, see Chalfonte & Johnson, in press.)

In normal conversations, one is not only comprehending a speaker's message but also typically processing perceptual cues from others, thinking about their motivation, drawing conclusions, and thinking about the points one wants to make, among other cognitive activities. Older adults may be less able to engage in this "multitasking," and one interesting possibility is that the binding of perceptual information to semantic information may be the most likely to suffer. If so, we would expect older adults to be less disadvantaged relative to younger adults in saying who said what in a multiperson conversation when they were not participating actively in the discussion than when they were.

Alternatively, older adults may encode critical perceptual information in the MFCOD condition as well as do younger adults but then have difficulty at test using multiple cues to make source monitoring judgments or may focus on or weight too heavily the less diagnostic cue. We think this second explanation is less likely than an encoding deficit explanation, but it cannot be ruled out with the present data alone.

An analysis of old–new recognition (see Tables 2 and 5) indicated that age-related source deficits were not simply a function of overall "weak" memory. First, in the first four conditions in Tables 1 and 2, recognition performance did not mirror source performance. Recognition did not increase in either age group when distinctiveness of cue increased, whereas distinctiveness improved source monitoring. Second, although older adults were hurt in source monitoring in the multiple cue conditions relative to the MF condition, they profited in old–new recognition in these same multiple cues conditions. Thus, in this situation, manipulations that increased recognition for older adults actually hurt their source monitoring. It is likely that older adults were benefiting on recognition from the self-generated activity of engaging in cognitive operations (e.g., Slamecka & Graf, 1978), and a deficit in binding and consolidating perceptual information would not be expected to affect their old–new recognition as much as it would their source monitoring (Johnson et al., 1993). Indeed, there is no evidence within the present studies that increasing perceptual distinctiveness of the two sources increased old–new recognition with cognitive operations held constant (compare FF to MF, FFCOS to MFCOS, and FFCOD to MFCOD), whereas there is clear evidence that adding cognitive operations improved old–new recognition (compare FF to FFCOS or FFCOD, and MF to MFCOS and MFCOD). Engaging in cognitive operations presumably increased old–new recognition, because participants were elaborating their semantic encodings of the old items. However, elaborated semantic encodings are not likely to carry information about source in this situation. That is, elaborating semantic encodings may improve performance on old–new recognition by increasing the familiarity or specificity of participants' responses to target items (e.g., Craik & Lockhart, 1972; Raye, 1976) but at the same time detract from the probability that they will encode perceptual and contextual details that might function as useful cues to source (Johnson & Raye, 1981; Johnson et al., 1993).

In short, compared to young adults, older adults sometimes showed equal levels of source monitoring and sometimes showed deficits (see also Hashtroudi et al., 1989). When the beneficial effect of increasing either perceptual or cognitive distinctiveness was equated for young adults, older adults showed equal benefits as well. In contrast, when potentially distinctive perceptual and cognitive cues were combined, older adults' source monitoring suffered. Furthermore, the age-related deficits in source monitoring cannot simply be accounted for by levels of old–new recognition, because (a) when age groups are equated on old–new recognition, older adults may (e.g., FF) or may not (e.g., MF) show source monitoring deficits; and (b) manipulations may affect old–new recognition and source monitoring in opposite ways (adding cognitive operations tasks improved older adults' recognition but hurt their source monitoring performance). Taken together, then, the pattern of source monitoring and old–new recognition data is consistent with the idea that older adults can engage in the sorts of cognitive activities that result in well-bound semantic and perceptual information but are less likely or able to do so when they are given an explicit demanding cognitive task to perform. We suggest that keeping track of the demands of making differential cognitive responses reduces reflective processing of potentially useful perceptual information beyond the reduction produced from generating a single type of response. We should, of course, be able in the future to set up tasks where making differential cognitive responses would help older adults bind perceptual and semantic information. The major point here is that older adults may be attending to and responding in a differential fashion to items said by two speakers yet show a deficit in their encoding or ability to use perceptual cues for source attributions.

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Received March 30, 1994
Revision received November 22, 1994
Accepted November 22, 1994 ■

Correction to Jagacinski et al.

In Figure 3 (p. 12) of "Generalized Slowing in Sinusoidal Tracking by Older Adults," by Richard J. Jagacinski, Min-Ju Liao, and Elias A. Fayyad (*Psychology and Aging*, 1995, Vol. 10, No. 1, pp. 8–19), the data points represented as solid squares should be open circles and vice versa to be consistent with the legend.