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Aging and Source Memory: Influences of Intention to Remember and Associations with Frontal Lobe Tests*

Alessio Degl'Innocenti[1,2] and Lars Bäckman[1,3]
[1]Göteborg University, Sweden, [2]Institute of Clinical Neuroscience, Department of Psychiatry and Neurochemistry, Göteborg University, Sweden, [3]Section of Psychology, Stockholm Gerontology Research Center, and Department of Clinical Neuroscience and Family Medicine, Division of Geriatrics, Karolinska Institute, Stockholm, Sweden

ABSTRACT

In a study modelled after Hashtroudi, Johnson, and Chrosniak (1989), young and older adults were examined in two conditions requiring reality monitoring (i.e., discriminating between one external and one internal source) and two conditions requiring source monitoring (i.e., discriminating between two external or two internal sources). Results indicated age-related deficits in internal source monitoring, although the two age groups did not differ in reality monitoring or external source monitoring. Explicit instructions to remember the source of information had no effect on performance. In addition, performance on putative tests of frontal lobe functioning (i.e., the Wisconsin Card Sorting Test and tests of verbal fluency) was unrelated to source memory performance. The results are discussed relative to the view that aging may affect the ability to encode perceptual information in a distinctive manner, as well as the ability to reconstruct perceptual information and its relationship to item information.

Episodic memory involves storage and retrieval of information encountered in a particular temporal-spatial context (Tulving, 1983). Age-related deficits in episodic memory tasks (e.g., word recall, face recognition) are legion in the literature; older adults typically perform at a lower level than young adults in tasks requiring recollection of episodic information (for reviews, see Kausler, 1991; Light, 1991; Salthouse, 1991). For the most part, the to-be-remembered information in this research has comprised the content of an event (e.g., a word list). In recent years, however, there has been an increasing interest also in memory for the context in which the event occurred (for a review, see Johnson, Hashtroudi, & Lindsay, 1993).

Information may originate from two general classes of sources; it may be externally derived (e.g., something that you heard from another person or saw in a television program) or internally generated (e.g., something that you said aloud or merely thought about). The process of discriminating between external and internal sources has been termed reality monitoring (Johnson & Raye, 1981). Reality monitoring may be distinguished from situations in which the person has to discriminate between two external sources, or between two internal sources. The latter types of situations are referred to as external source monitoring and internal source monitoring, respectively (e.g., Foley & Johnson, 1985; Johnson & Foley, 1984). In reality moni-

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Address correspondence to: Lars Bäckman, Department of Psychology, Göteborg University, Haraldsgatan 1, S-413 14 Göteborg, Sweden.
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toring, the individual may utilize the different kinds of information that distinguish an external from an internal source. For example, if a particular memory involves much sensory information and meaningful contextual details, it is likely to be classified as externally derived. By contrast, if the memory involves information about the cognitive operations that took place when it was established (e.g., that a visual image was formed), it is likely to be classified as internally generated. In external or internal source monitoring, on the other hand, the available information is likely to involve similar amounts of sensory and cognitive information. As a result, discriminating between memories from the same class (e.g., external vs. external source; internal vs. internal source) is typically more difficult than between-class discriminations (e.g., Ferguson, Hashtroudi, & Johnson, 1992; Raye & Johnson, 1980). Conceivably, an important reason for this is that within-class discriminations require a more distinctive encoding of contextual and cognitive features compared with between-class discriminations.

Age-related deficits in external source monitoring are well established. For example, there is evidence that older adults perform at a lower level than young adults in tasks requiring recollection of whether the information was presented visually or auditorily (Lehman & Mellinger, 1984; McIntyre & Craik, 1987), by one person or another person (Schacter, Kaszniak, & Valdiserri, 1994), as a word, an object, or an action (Larsson & Bäckman, 1994), in upper or lower case letters (Kausler & Puckett, 1980), or in a particular color (Erngrund, Mäntylä, & Nilsson, in press; Park & Puglisi, 1985). Likewise, internal source monitoring (e.g., to tell whether some information was verbalized or imagined) has been found to be more difficult for older adults than for younger adults (e.g., Hashtroudi et al., 1989; Hashtroudi, Johnson, Vnek, & Ferguson, 1994; Rabinowitz, 1989).

An important issue concerns whether age-related deficits in source memory are selective, or merely an expression of a general age-related deficit in episodic memory. In some studies reporting age-related deficits in source memory (e.g., Cohen & Faulkner, 1989; Kausler & Puckett, 1981), age-related deficits in item memory were also obtained, hence leaving open the possibility that memory for source is no more affected by the adult aging process than memory for content. However, in other research age differences in item memory have been controlled, either by conditionalizing source memory scores on item memory scores, or by matching the age groups on level of item memory. The overall impression from this research is that age-related deficits in source memory remain after controlling for item memory performance (e.g., Ferguson et al., 1992; Hashtroudi et al., 1989; Hashtroudi et al., 1994; Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991; Schacter, Osowiecki, Kaszniak, Kihlstrom, & Valdiserri, 1994). This suggests that external and internal source monitoring may be selectively disrupted by aging. However, this is not to say that item and source memory involve qualitatively different processes. Rather, in the typical case, the two forms of memory may differ in the degree of differentiation required at encoding and subsequent retrieval (Johnson et al., 1993).

An interesting observation made by Hashtroudi et al. (1989) is that aging may exert less adverse effects on reality monitoring than on source monitoring. These investigators compared younger and older adults in tasks requiring discrimination between (a) two external sources; (b) two internal sources; or (a) one internal and one external source. Results indicated age-related deficits in the two source monitoring tasks, although the two age groups did not differ in reality monitoring. A likely explanation of these results is that within-class discriminations typically require a more distinctive encoding of perceptual and cognitive information compared with between-class discriminations. Age-related deficits in processing of contextual detail are well documented (e.g., Light & Zelinski, 1983; Park, Puglisi, & Lutz, 1982). Likewise, there is evidence that older adults have problems in spontaneously engaging in elaborative cognitive processes (e.g., Craik, 1984; Craik & Byrd, 1982).

In addition, it has been demonstrated that the magnitude of age-related impairments in memory for source may vary as a function of the instructions provided to the subjects. Hashtroudi et al. (1994) had subjects engaged in a short play. Following the play, they were asked to talk about factual or affective aspects of the play, or to talk about the play without any particular focus suggested. Results showed marked age-related deficits in both internal source monitoring (i.e., the information was said vs. thought of by the subject) and reality monitoring (i.e., the information was said by the subject vs. said by another person) in both the affective and control condition. However, when subjects were asked to focus on factual content, the size of the age deficit was attenuated in internal source monitoring and eliminated in reality monitoring. Although these data suggest that reality monitoring may be less affected by aging than source monitoring, they indicate that age-related deficits may occur in reality monitoring (see also Brown, Jones, & Davis, 1995; Hashtroudi, Johnson, & Chrosniak, 1990; Rabinowitz, 1989). Conceivably, the crucial factor is the salience of those features that separate different sources rather than the type of monitoring task per se (Johnson et al., 1993). Additional evidence for this view comes from research indicating eliminated age differences in external source monitoring when sources are easily discriminable (e.g., in terms of gender; Ferguson et al., 1992; Johnson, De Leonardis, Hashtroudi, & Ferguson, 1995).

Considering that the results of Hashtroudi et al. (1994) suggest that attentional focus may determine the size of age-related source memory deficits, it is noteworthy that most research addressing age-related differences in source memory has employed incidental learning instructions, that is, subjects have not been informed in advance of a forthcoming source memory test. Given that older adults have deficits in spontaneously focusing the attention on stimulus attributes that may be relevant to proficient source memory functioning (e.g., Bäckman & Nilsson, 1985; Mäntylä & Bäckman, 1992; for a review, see Craik & Jennings, 1992), explicit instructions to memorize the source of information may be especially important for older adults.

It has been suggested that source memory is dependent on the integrity of prefrontal cortical structures. Initial evidence for this view came from research indicating pronounced source memory deficits in patients with frontal lobe lesions (Janowsky, Shimamura, & Squire, 1989; Schacter, Harbluk, & McLachlan, 1984). Research showing strong relationships between neuropsychological indexes linked to the frontal lobes (e.g., the Wisconsin Card Sorting Test or WCST and tests of word fluency) and measures of source memory in both young (Glisky, Polster, & Routhieaux, 1995) and older (Craik, Morris, Morris, & Loewen, 1990) adults, provides further support for the role of the frontal cortex in source memory. However, other studies have failed to document relationships between tests of frontal lobe functions and source memory (Dywan, Segalowitz, & Williamson, 1994; Erngrund et al., in press; Johnson et al., 1995; Spencer & Raz, 1994).

The purpose of the current research was to provide further knowledge with regard to age-related differences in memory for source. In particular, we were interested in the potential modifiability of age-related source memory deficits through directed instructions to memorize the origin of information. Another aim was to provide additional information regarding the relationship between neuropsychological frontal lobe measures and source memory performance in adulthood and aging.

Groups of young and older adults participated in a study modelled after Hashtroudi et al. (1989). Subjects were presented with word lists under four encoding conditions. In two of these conditions, the words originated from two external sources (i.e., a male or a female assistant) or from two internal sources (i.e., subjects said some words aloud and thought about others). In the other two conditions, the words originated from either an external or an internal source (i.e., subjects said or thought about some words and listened while an assistant said other words). To manipulate intentionality at acquisition, subjects received incidental or intentional learning instructions with regard to the forthcoming source memory test.

On the basis of previous research (e.g., Hashtroudi et al., 1989; Hashtroudi et al., 1994), we expected larger age differences in source monitoring than in reality monitoring. Further, given that gender could be used as a discriminating cue in the external source monitoring condition, we expected smaller age differences in that condition compared with the internal source monitoring condition (Ferguson et al., 1992; Johnson et al., 1995). Our chief objective, however, was to examine whether the predicted age-related deficits in source monitoring would be reduced following intentional learning instructions. Finally, we administered the WCST and tests of verbal fluency to assess the relationship between frontal lobe functions and source memory. To our knowledge, the relative influence of frontal lobe tests on reality monitoring and source monitoring has not been examined in prior research. Provided that (a) source monitoring requires a more distinctive encoding and a more elaborate reconstruction of perceptual and cognitive information than does reality monitoring (e.g., Hashtroudi et al., 1989; Johnson et al., 1993), and (b) the frontal lobes play an important role in these processes (e.g., Moscovitch, 1994; Schacter et al., 1994; for a review, see Nyberg, Cabeza, & Tulving, 1996), it may be that tests of frontal lobe functioning are more strongly related to measures of source monitoring than to measures of reality monitoring.

METHOD

Subjects

Subjects were 192 healthy volunteers. Ninety-six subjects were between 18 and 30 years of age and 96 were between 65 and 86 years of age. The younger subjects were undergraduate students. The older subjects were community-dwelling and non-institutionalized, and were recruited by newspaper advertisements. Subjects received the equivalent of $14 (U.S.) for their participation.

All subjects completed a questionnaire, the purpose of which was to exclude subjects who were not healthy. Exclusion criteria included: diabetes, multiple sclerosis, Parkinson's disease, stroke or other neurological diseases (e.g., dementia), paralysis, brain infections, abuse of alcohol or narcotics, cramps, epilepsy, episodes of unconsciousness, shivers, tremors, disturbance of balance, confusion, and psychiatric diseases (e.g., depression). To be included, subjects also had to have sufficient visual and auditory capabilities (uncorrected or corrected) to manage the sensory demands of the study. No subject was excluded due to the exclusion criteria employed. There were no age differences in level of schooling or gender distribution ($ps > .10$). Demographic characteristics of the study samples are shown in Table 1.

Psychometric Testing

All subjects were administered a battery of neuropsychological tests, including the Vocabulary subtest from the Wechsler Adult Intelligence Scale – Revised (WAIS-R; Wechsler, 1981) as well as two tests assumed to reflect frontal lobe functioning: the Controlled Oral Word Association Test (Benton & Hamsher, 1989) and the WCST (Harris, 1990; Heaton, 1981). These tests were administered after the assessment of source memory.

The word association test assesses verbal fluency and involves generating as many words as possible beginning with the letters F, A, and S, with the exception of proper names, numbers, and words with the same suffix. One minute was al-

Table 1. Demographic Characteristics of the Study Samples.

	Younger adults	Older adults
n	96	96
Female	50	62
Male	46	34
Age		
M	21.39	70.75
SD	3.14	4.92
Years of education		
M	12.98	12.29
SD	1.58	4.43

lowed for each letter. The WCST was administered in computerized format (Harris, 1990). The complete 128 card-version was used. The 11 measures derived from the WCST were: the number of categories completed; the number of trials; the number of correct responses; the number of errors; the number of perseverative responses (i.e., responses that would have been correct in the previous stage); the number of perseverative errors (i.e., perseverative responses that were also errors); the number of nonperseverative errors (i.e., the number of errors minus the number of perseverative errors); the number of trials to complete the first category; the percentage of conceptual level responses (i.e., the number of conceptual level responses divided by the number of trials); failure to maintain set (i.e., the number of times the subject made five correct responses in a row but failed to make the 10 responses that are required to complete the category); and the "learning to learn" score (i.e., the average change in efficiency across the successive stages of the test). Performance by younger and older adults on the psychometric tests shown in Table 2.

An ANOVA on the WAIS-R Vocabulary data revealed a superiority of older compared with younger subjects, $F(1, 40) = 6.85$, $MSE = 76.89$, $p < .01$, $\omega^2 = .029$. The analysis of the verbal fluency data revealed no age differences for the total FAS score, or for any of the three separate letters ($Fs < 1$). By contrast, all WCST variables, except the total number of correct responses ($p > .05$), showed significant main effects of age in favor of the younger adults: number of categories completed, $F(1, 190) = 34.14$, $MSE = 4.62$, $p < .0001$, $\omega^2 = .15$; number of trials, $F(1, 190) = 40.34$, $MSE = 413.68$, $p < .0001$, $\omega^2 = .12$; number of errors, $F(1, 190) = 38.67$, $MSE = 587.71$, $p < .0001$, $\omega^2 = .18$; number of perseverative responses, $F(1, 190) = 39.40$, $MSE = 340.93$, $p < .0001$, $\omega^2 = .17$; number of perseverative errors, $F(1, 190) = 26.84$, $MSE = 176.26$, $p < .0001$, $\omega^2 = .17$; number of nonperseverative errors, $F(1, 190) = 36.60$, $MSE = 187.55$, $p < .0001$, $\omega^2 = .12$; number of trials to complete the first category, $F(1, 190) = 10.65$, $MSE = 678.60$, $p < .01$, $\omega^2 = .05$; percentage of conceptual level responses, $F(1, 190) = 35.61$, $MSE = 574.77$, $p < .0001$, $\omega^2 = .15$; failure to maintain set, $F(1, 190) = 15.54$, $MSE = 2.15$, $p < .0001$, $\omega^2 = .08$; and "learning to learn," $F(1, 190) = 16.36$, $MSE = 40.34$, $p < .0001$, $\omega^2 = .07$.

Experimental Design

The basic design was a 2 × 4 × 2 × 2 factorial, with age (younger adults, older adults), source condition (say-listen, think-listen, say-think, listen-listen), encoding instruction (intentional, incidental) and presentation order. A total of 24 younger and

Table 2. Psychometric Performance by Younger and Older Adults.

	Younger adults		Older adults	
Psychometric tests	*M*	*SD*	*M*	*SD*
Vocabulary[a]	48.01	8.28	51.32	9.23
FAS[b]	40.43	9.16	41.19	10.82
F	13.65	3.85	14.11	3.97
A	11.60	3.02	12.01	4.13
S	15.18	3.81	15.27	4.68
WCST[c]				
Categories completed	4.56	2.15	2.75	2.15
Number of trials	101.30	23.37	119.95	16.77
Correct responses	68.88	10.58	65.15	15.64
Number of errors	32.43	23.88	54.82	24.10
Perseverative responses	18.25	14.59	40.01	31.02
Perseverative errors	16.36	12.54	33.09	22.90
Nonperseverative errors	16.06	12.94	25.99	13.60
Trials to complete first category	15.63	12.38	27.90	34.70
% conceptual level responses	62.23	24.11	41.59	23.84
Failure to maintain set	0.84	1.03	1.68	1.80
"Learning to learn"	–0.89	4.77	–4.59	7.61

[a] From the Wechsler Adult Intelligence Scale – Revised (Wechlser, 1981).
[b] From Benton and Hamsher (1989).
[c] Wisconsin Card Sorting Test – computerized version 1.0 (Harris, 1990).

24 older subjects were tested in each source condition. Half of these received intentional learning instructions and half received incidental learning instructions. Within each grouping of 12 subjects, half received the study list in one order, and the other half received the study list in reversed order. The materials consisted of 60 nouns selected randomly from a pool of words developed by Molander (1984). The words were selected so as to be comparable with regard to frequency, concreteness, and imagery. Half of the words were randomly assigned as targets and the other half served as distractors in a later memory test. In the target list, 15 words were assigned to either category in each source condition (e.g., 15 words as *say* items and 15 words as *listen* items in the say-listen condition). The words were counterbalanced so that each word appeared equally often as targets and distractors. When a word served as a target, it appeared equally often in each source category (e.g., say vs. listen). The words from the target list were presented randomly with the restriction that more than three words originating from a particular source (e.g., listen) were never presented in succession. The 60 words in the test list were also randomized, but with two restrictions: The words at the beginning and the end of the study list were not presented at the beginning or the end of the test list, and two words presented after each other in the study list were not presented in the same order in the test list.

Procedure

All subjects were tested individually. At study, words were presented at a rate of 4 s per word. Half of the subjects were instructed to pay close attention to the words and to try to memorize the source of each word for a later monitoring test (intentional instructions). The other half of the subjects were also instructed to pay close attention to the items. However, following Hashtroudi et al. (1989), these subjects were told that the purpose of the experiment was to obtain control data on adults to compare with data on children (incidental instructions). No mention was made of a forthcoming memory test to these subjects.

All words were presented twice. The experimenter read each word aloud and indicated who (the subject or an assistant) should repeat the word and how it should be repeated. This was done by pointing at the source in question. Four practice trials preceded the experiment proper. In the *say-listen* condition there was, in addition to the experimenter and the subject, an assistant in the room. The subject was instructed to repeat aloud the words that the experimenter told him/her to say and to listen carefully to the words that the assistant repeated aloud. In the *think-listen* condition, there was also an assistant in the room. The subject was instructed to think of himself/herself repeating aloud the words that the experimenter told him/her to think of, and to listen carefully to the words the assistant repeated aloud. The subject was told to imagine himself/herself saying the words aloud (covertly pronouncing them), and not only elicit a visual image of the word. After the four practice trials, subjects were asked to tell the experimenter what they did when they thought of the words. If they used an incorrect strategy (e.g., elicited the visual image of a word, instead of imagining themselves covertly pronouncing the word), the instructions were repeated.

In the *say-think* condition, the subject was instructed to repeat aloud the words the experimenter told him/her to say, and to think of himself/herself repeating other words aloud. In these three conditions, the sources were identified by the experimenter noting the source in question after each word had been presented (e.g., say, listen, think). In the *listen-listen* condition, there were two assistants in the room, one male and one female. The experimenter asked the first assistant to repeat some words aloud and asked the second assistant to repeat other words aloud. Here, the two sources were identified by the experimenter pointing at the intended source.

Following presentation of the word lists, subjects received a source monitoring test. Most of the subjects who received incidental encoding instructions appeared to be surprised by this test. All subjects received a test booklet with 60 words, half of which were targets and half of which were distractors. For the say-listen condition, subjects were asked to decide whether an item was a word they had said (letter S), a word they had listened to (letter L), or a new word (letter N) by circling the appropriate response. In the think-listen condition, they encircled letter T (thought), L, or N, and in the say-think condition they encircled letter S, T, or N. Finally, in the listen-listen condition, subjects encircled 1 (assistant 1/male), 2 (assistant 2/female), or N (new). The source monitoring test was self-paced and no subject required more than 5 minutes for completion.

RESULTS

Source Monitoring

Subjects sometimes identified an old item correctly, although they attributed it to the wrong source. To calculate the source monitoring score for each subject, the total number of words attributed to the correct source was divided by the total number of words correctly identified as old (e.g., Hastruoudi et al., 1989). For example, in the think-listen condition, the source monitoring score refers to the number of words correctly identified as T items plus the number of words correctly identified as L items divided by the total number of words correctly identified as old. In all analyses to be reported, presentation order (2 levels) was initially used as a variable. However, there were no effects involving presentation order and, hence, the data were collapsed across this variable.

A 2 (Age) × 4 (Source Condition) × 2 (Encoding Instruction) factorial ANOVA was carried out on the source memory data. This ANOVA showed a significant main effect of source condition, $F(3,160) = 3.20$, $MSE = .065$, $p < .03$, $\omega^2 = .16$. A Tukey test indicated lower performance in the say-think condition compared with the say-listen and think-listen conditions ($ps < .05$), although the listen-listen condition did not differ from any other condition ($ps > .10$). The main effect of age was marginally significant, $F(1,160) = 3.48$, $p < .07$, $MSE = .020$, $\omega^2 = .015$, with the young adults ($M = .75$, $SD = .13$) generally performing better than the older adults ($M = .71$, $SD = .15$). However, the effect of encoding instruction fell far short of significance ($F < 1$). Mean overall source monitoring scores were .74 ($SD = .14$) and .72 ($SD = .15$) following intentional and incidental learning instructions, respectively. Although the Age x Source Condition interaction failed to approach conventional significance ($p > .10$), further analysis comparing source monitoring scores for younger and older adults showed that the effect of age was significant in the say-think condition, $F(1, 46) = 7.09$, $MSE = 0.16$, $p < .02$, $\omega^2 = .110$. In the remaining three conditions, the age effect was not reliable ($ps > .10$). Source monitoring scores across age and condition are portrayed in Figure 1.

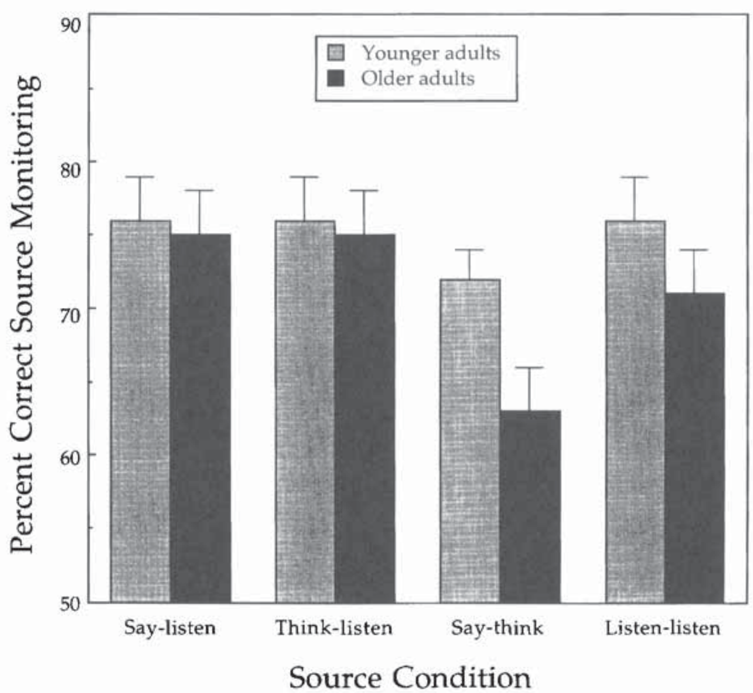

Fig. 1. Mean percentage correct source monitoring across age and condition. (Error bars represent standard errors around the means.)

Old-New Recognition

For the analysis of recognition of old and new items without regard to correct identification of the source, d' scores were computed. In general, recognition was higher for younger ($d' = 2.15$) than for older ($d' = 1.85$) adults, $F(1, 160) = 8.88$, $MSE = 0.10$, $p < .003$, $\omega^2 = .050$. However, there was no effect of source condition or encoding instruction, and no interaction effects in this analysis (all Fs < 1).

Recognition of Different Types of Items

In the say-listen condition, both younger and older subjects had a larger number of hits for S items than for L items, $F(1, 40) = 18.56$, $MSE = 3.10$, $p < .0001$, $\omega^2 = .29$. Likewise, in the think-listen condition, there were more hits for T items than for L items, $F(1, 40) = 31.04$, $MSE = 3.63$, $p < .0001$, $\omega^2 = .42$. There was also an interaction effect between age and type of hit, $F(1, 40) = 12.50$, $MSE = 3.63$, $p < .001$, $\omega^2 = .21$, indicating that the advantage of T items was greater for older than for younger adults. In the say-think condition there was a main effect of age, $F(1, 40) = 5.72$, $MSE = 10.52$, $p = < .022$, $\omega^2 = .015$, such that younger adults produced more hits than older adults. In the listen-listen condition there was no main effect of age or type of item (Fs < 1). No effects involving encoding instruction were found in any of these analyses. Table 3 shows the mean number of hits for the respective sources across age and source condition.

False Alarms

Mean number of false alarms for each type of item across age and source condition are shown in Table 4. In the say-listen condition, subjects were more likely to mistakenly identify a new item as an L item rather than as an S item, $F(1, 40) = 22.49$, $MSE = 7.63$, $p < .0001$, $\omega^2 = .34$, and in the think-listen condition they were more likely to mistakenly identify a new item as an L item rather than as a T item, $F(1, 40) = 15.48$, $MSE = 10.35$, $p = .001$, $\omega^2 = .26$. In the say-think and listen-listen conditions, there was no bias toward attributing new items to either source. No effect of age or encoding instruction was found in any of these analyses.

Source Memory and Frontal Lobe Measures

To determine potential relationships between performance on the frontal lobe tests and source memory scores, a series of product-moment correlations were computed. In these analyses, all FAS and WCST variables were correlated with performance in (a) the four source conditions taken separately; and (b) the within- and be-

Table 3. Mean Number of Hits for Each Type of Item Across Age and Source Condition.

	Younger adults		Older adults	
Condition	*M*	*SD*	*M*	*SD*
Say-listen				
Hits for S items	10.13	2.27	10.42	2.39
Hits for L items	9.04	2.49	8.46	3.01
Think-listen				
Hits for T items	9.67	2.60	11.13	2.15
Hits for L items	8.86	2.27	7.58	2.55
Say-think				
Hits for S items	7.71	2.66	6.88	2.98
Hits for T items	8.58	3.02	6.25	3.31
Listen-listen				
Hits for L_1 items	9.67	2.66	8.58	2.19
Hits for L_2 items	9.41	2.83	8.88	2.79

Table 4. Mean Number of False Alarms for Each Type of Item Across Age and Source Condition.

	Younger adults		Older adults	
Condition	*M*	*SD*	*M*	*SD*
Say-listen				
New items called S	1.29	2.65	2.33	3.33
New items called L	3.88	4.25	5.04	3.07
Think-listen				
New items called T	1.58	2.08	2.50	3.11
New items called L	3.67	4.11	5.58	4.70
Say-think				
New items called S	1.29	1.57	3.04	3.74
New items caled T	3.17	2.82	3.08	3.02
Listen-listen				
New items called L_1	3.70	3.69	3.67	4.19
New items called L_2	3.17	2.83	2.79	2.65

tween-class conditions, respectively. Further, correlations were computed within each age group as well as for the total sample. Of the 174 correlations computed, none attained conventional significance using Bonferroni corrections. Thus, the results from these analyses argue strongly that the current measures of frontal lobe functioning and source memory were unrelated.

DISCUSSION

The purpose of this research was to provide further knowledge regarding how aging affects the processes of reality monitoring and source monitoring. Of particular interest was whether (a) explicit instructions to encode the source of information would reduce the magnitude of age-related performance deficits, and (b) tests of frontal lobe function would be related to the source memory measures employed. In general, the results pertaining to age differences in the various monitoring conditions were in good agreement with prior research.

First, consistent with Hashtroudi et al. (1989), there were no age-related differences in the two reality monitoring conditions; when subjects had to decide whether a word originated from an internal (i.e., a word that was said aloud or thought about by the subject) or an external (i.e., a word that was said by an assistant) source, older adults did as well as young adults. The finding of no age-related differences in the two between-class conditions suggests that older adults may be equally able as young adults in utilizing information about cognitive operations (internal sources) and perceptual/contextual information (external sources) to decide whether a particular word was generated or perceived.

Second, there were age-related deficits in the condition requiring discrimination between two internal sources (i.e., said vs. thought), although the two age groups did not differ when subjects had to discriminate between two external sources (i.e., one assistant vs. another assistant). In the internal source monitoring condition, the types of information available to discriminate between the sources are likely to be more similar, increasing the demands of distinctive and elaborate processing. Thus, the age-related deficit observed in this condition may have resulted from less efficient encoding and reconstruction of perceptual and cognitive information in older compared with young adults (Hashtroudi et al., 1989; Schacter et al., 1994). Analogously, the lack of age differences in external source monitoring likely reflects the fact that a man and a woman comprised the two external sources in this study. Several studies (e.g., Ferguson et al., 1992; Johnson et al., 1995) suggest that the magnitude of age differences in external source monitoring varies as a function of the salience of the sources, and that gender may be a powerful cue in discriminating between external sources.

The item memory data were also in good agreement with previous research: Recognition accuracy, as indexed by *d*' scores, was higher in young than in older adults (e.g., Hashtroudi et al., 1989; Hashtroudi et al., 1994; Larsson & Bäckman, 1994). The hit rate data revealed generation effects (Slamecka & Graf, 1978) in both young and older adults (Hashtroudi et al., 1989; Mitchell, Hunt, & Schmitt, 1986), such that both age groups produced more hits for items that were said aloud or thought of compared with those that were listened to. In addition, the young adults produced more hits than the older adults in the say-think condition, although there were no age-related differences in hit rates in the remaining three source conditions. Thus, the hit rate data paralleled the source memory data, indicating a superiority on the part of the young adults only in the internal-internal condition.

There were no age differences in false alarm rates, and false alarms were more likely to be attributed to an external than to an internal source. The latter finding may also reflect a generation effect; the fact that most false alarms were attributed to external sources may result from both age groups regarding self-generated items as more memorable than externally provided items. The age invariance in false alarms indicates that the observed age-related differences in internal source monitoring may not be due to differences in reasoning and judgment processes between age groups (cf. Hashtroudi et al., 1989).

Furthermore, a striking result from the present study was the complete lack of effect of the instructional manipulation. Irrespective of whether or not subjects received explicit instructions to remember the sources, memory performance was at the same level. Following the criteria for automatic and deliberate cognitive operations outlined by Hasher and Zacks (1979), it may be argued that the lack of effect of intentionality reflects that remembering the source of information requires a minimal amount of processing resources. However, prior research indicates that source memory, indeed, requires a distinctive encoding of perceptual and cognitive information. For example, findings that amnesics (Janowsky et al., 1989; Schacter et al., 1984; Shimamura & Squire, 1987) and older adults (Ferguson et al., 1992; Hashtroudi et al., 1994; Schacter et al., 1991; Schacter et al., 1994) are disproportionately impaired in source memory relative to item memory, are difficult to reconcile with the view that encoding of source information requires little elaborative processing. On the contrary, Johnson et al. (1993) presented evidence that source memory may depend on higher levels of perceptual and cognitive differentiation than item memory. In a related vein, there is agreement that memory for contextual information in general (of which source memory is one example) taxes basic processing resources (e.g., Craik & Jennings, 1992; Light, 1991). Further, it is generally accepted that the internal-internal condition used in this study is more cognitively demanding than the other conditions (e.g., Johnson et al., 1993). Thus, to the extent that effects of intentionality at encoding reflect degree of deliberation, we would have expected greater effects of the instructional manipulation in the internal-internal condition than in the remaining conditions. As noted, this was not the case.

A more likely reason for the lack of effect of intentionality is that the instructional manipulation was too weak to produce any measurable effects on source memory performance. Given that proficient source memory functioning requires associating perceptual/cognitive and item information (Schacter et al., 1994), the fact that the same instructions were provided with regard to item information (i.e., to pay close attention to the words) in both instructional conditions, may have precluded the influence of intentionality on source memory. In addition, to the extent that source memory also draws on the ability to reconstruct perceptual information (Schacter et al., 1994), it should be noted that the instructions provided at retrieval were identical for both encoding conditions. Finally, the fact that several pretraining trials were given, as well as the instructions provided in the incidental condition (i.e., to contribute data for comparison with children), may have focused these subjects' attention on task-relevant information. In any event, the lack of effects of intention to remember source imply that the current data not only replicate previous patterns of age-related differences and similarities in source and reality monitoring, but also extend earlier findings to learning situations that focus the subject on remembering the origin of information.

The attempt to link neuropsychological measures of frontal lobe functioning to source memory performance met with no success. As noted, evidence has been mixed with regard to the relationship between frontal lobe and source memory tests, with some studies showing a positive association (e.g., Craik et al., 1990; Glisky et al., 1995) and others not (e.g., Dywan et al., 1994; Spencer & Raz, 1994). Obviously, the fact that none of the 174 correlations between the WCST and fluency variables, on the one hand, and the different source memory scores, on the other, approached statistical significance, strongly suggests that the present frontal lobe and source memory measures share little variance.

A potential reason for the nonexistent relationship between the frontal and source memory tests may be that the measures are unreliable. This seems unlikely, however, given that (a) the frontal tests are standardized neuropsychological measures, and (b) the source memory data were in good agreement with related prior research. Another possibility is that the current neuropsychological tests, the source memory tests, or both, do not reflect accurately frontal lobe functioning. In a related vein, even though these tests may draw partly on the integrity of the frontal lobes, other cortical and subcortical structures may be involved as well, and different frontal structures may be critical to the present neuropsychological and source memory tests (Johnson et al., 1995).

Given these considerations, several observations from prior research are noteworthy. First, those studies demonstrating a relationship between frontal and source memory tests have used the fictitious facts paradigm devised by Schacter et al. (1984) rather than other tests of source memory. Second, it has been argued that some putative tests of frontal lobe functioning (e.g., word fluency) may be insensitive markers of executive functions, or tap different executive functions than source memory (Erngrund et al., in press; Schacter et al., 1991). Third, although performance on the WCST has been found to be associated with increased blood flow in prefrontal areas (e.g., Weinberger, Berman, & Zec, 1986), research comparing patients with circumscribed frontal lesions and patients with damage to other cortical and subcortical structures indicates no difference between groups in WCST performance (Anderson, Damasio, Jones, & Tranel, 1991). Finally, research suggests that temporal and diencephalic (e.g., Brown & Brown, 1990; Mayes, Meudell, & Pickering, 1985) as well as parietal (Dywan et al., 1994) regions may be involved in memory for source. All these issues may be important to consider in evaluating the presence or absence of a relationship between putative frontal tests and tests of source memory.

In summary, the present research indicates an age-related deficit in internal source monitoring, although reality monitoring as well as external source monitoring was unaffected by age. The finding that age-related deficits in source monitoring, under some conditions, may be disproportionate to age-related deficits in item memory is consistent with a recent meta-analysis of age differences in memory for context and content (Spencer & Raz, 1995). In addition, intention to memorize the origin of information as well as neuropsychological tests of frontal lobe functions had no influence on either reality monitoring or source monitoring. It has been suggested that age-related deficits in source memory may result from problems in encoding perceptual information distinctively (e.g., Erngrund et al., in press; Ferguson et al., 1992; Hashtroudi et al., 1989) as well as from problems in reconstructing perceptual information and its association with item information (Schacter et al., 1994). Whether these proposals are empirically distinguishable by analytical experimentation, or manifestations of a common underlying source, remains to be determined by future research.

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