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Aging and Source Monitoring

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This experiment was designed to examine the ability of older and younger adults to remember the source of information. Three types of source monitoring tasks were investigated: discriminating between externally derived and internally generated memories, discriminating between two types of internally generated memories, and discriminating between two types of externally derived memories. Relative to younger adults, older adults had more difficulty discriminating between memories of the same class (external–external and internal–internal), but they did not have more difficulty discriminating between memories of different classes (external–internal). These findings indicate that the age-related difficulty in remembering the source of information should not be characterized as a general deficit. Factors that may account for age deficits in source monitoring are discussed drawing upon the Johnson–Raye (1981) reality monitoring framework.

Age-related deficits in remembering the content of information have been clearly established (Burke & Light, 1981; Craik, 1977; Salthouse, 1982). Of growing interest is whether older adults also show a deficit in remembering the source of information. Specifically, Burke and Light (1981) have reviewed a wide range of studies showing that older adults have difficulty in remembering contextual information. Moreover, one recent account (McIntyre & Craik, 1987) has suggested that *source amnesia,* similar to that found in amnesic patients (Schacter, Harbluk, & McLachlan, 1984), may also characterize the memory deficits in older adults. The present experiment was designed to further investigate potential age deficits in remembering the source of information.

One theoretical account of memory for source information is the *reality monitoring* model proposed by Johnson and Raye (1981). Reality monitoring refers to a set of processes involved in discriminating between externally derived and internally generated information in memory (Johnson & Raye, 1981). According to this model, there are characteristic differences between memories of externally derived and internally generated events. Reality monitoring is a function of these characteristics as well as of judgment processes. Generally, externally derived memories have more sensory information (e.g., sound, color), more spatial/temporal information, and more meaningful details than do internally generated memories. On the other hand, internally generated memories have more information about the cognitive operations engaged in when the memory was established. Many reality monitoring decisions are made on the basis of differences in average value along these dimensions. Reality monitoring decisions may also involve reasoning processes based on retrieving additional information from memory. These processes are affected by prior knowledge and by one's assumptions about how memory functions (e.g., metamemory).

The reality monitoring model suggests that people are generally successful in discriminating between memories of externally derived and internally generated events because these two types of memories differ on critical information dimensions. Nevertheless, there are two potential sources of errors in reality monitoring. First, a memory may not be typical of its class. For example, an internally generated memory with a lot of sensory information (e.g., a vivid imagination) might be mistakenly judged as externally derived. Second, a person might fail to engage in appropriate reasoning processes.

The reality monitoring model was initially formulated to account for how people discriminate between externally derived and internally generated memories. However, the model may be extended to other source monitoring situations: (a) discriminating between two internally generated sources, or internal source monitoring (e.g., discriminating one's thoughts from what one says), and (b) discriminating between two externally derived sources, or external source monitoring (e.g., discriminating statements made by one person from statements made by another person; Foley & Johnson, 1985; Foley, Johnson, & Raye, 1983; Johnson, 1988; Johnson & Foley, 1984; Johnson & Lindsay, 1986; Lindsay, 1987). Similar to reality monitoring, both internal and external source monitoring would involve attribution processes based on memory characteristics (e.g., sensory,

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spatial/temporal, semantic, and cognitive operations information) and on reasoning in light of prior knowledge and assumptions about memory. In the case of internal source monitoring and external source monitoring, however, discriminations would be less likely to be based only on the *amount* of information of a given type because memories from the same class are likely to include similar amounts of sensory information, information about cognitive operations, and so forth. Thus, within-class discriminations typically should require more specific information (e.g., an evaluation of the specific sensory content of the memory; Lindsay, 1987).

In general, within-class discriminations (internal and external source monitoring) should be more difficult than between-class discriminations (reality monitoring). For example, the memories of words you heard two speakers say should have approximately the same amount and types of cognitive operations information. In contrast, compared with memories of words you heard, memories of words you said should have both more and different cognitive operations. It might be possible, however, to have an external source monitoring task in which the differences in memory characteristics (e.g., sensory) between the two external sources are quite large. When compared with a reality monitoring task in which the differences between the external and internal sources are small, external source monitoring may lead to better performance. Thus, the critical idea here is not that there is an invariant order of source monitoring tasks in terms of difficulty, but rather that there are multiple dimensions along which similarity can operate to create confusions among memories.

The results of studies that have directly examined source monitoring in older adults have been mixed. It appears that the ability to remember the source of information depends to some extent on the type of source monitoring process. Reality monitoring in older adults was examined by Mitchell, Hunt, and Schmitt (1986). In this study, older adults did not differ from younger adults in remembering the source of information (read vs. generate). As the authors noted, however, a ceiling effect in the performance of younger adults could have masked a reality monitoring deficit. Furthermore, it is important to note that this study required a decision between internally generated and externally derived memories. As mentioned earlier, between-class discriminations may be easier than within-class discriminations and, thus, may be less sensitive to age deficits.

Internal source monitoring was investigated in a study by Kausler, Lichty, and Freund (1985). Younger and older adults were asked to estimate the frequency of planning and performing various activities (e.g., card sorting). The results indicated that older adults did not have difficulty discriminating between memories for performing and planning activities. It is possible, however, that age-related deficits in source monitoring may be difficult to detect with complex events (e.g., card sorting) when memory for these events is tested after a short retention interval, as in this experiment.

Evidence for age-related deficits in external source monitoring is provided by a number of studies that have shown age-related decrements in remembering sex of voice (Kausler & Puckett, 1981a, 1981b), case format (Kausler & Puckett, 1980, 1981a), list membership (Zelinski & Light, cited in Burke & Light, 1981), and other contextual aspects of information (see Burke & Light, 1981, for a review). In a recent study (McIntyre & Craik, 1987), older and younger adults were taught real or made-up facts and were asked to remember the source of these facts. Older adults had large deficits in remembering the presentation modality (experimenter vs. overhead projector). In addition, they had difficulty in remembering whether a fact was learned in the experiment or whether it came from another source (e.g., television, newspapers).

In the present study, we examined source monitoring in older adults by drawing upon the reality monitoring framework (Johnson & Raye, 1981). We compared the three types of source monitoring processes (reality monitoring, internal source monitoring, and external source monitoring) within the same experiment. The major issue addressed was whether older adults have a general deficit in remembering the source of information or whether age deficits are limited only to certain types of source monitoring processes. To examine source monitoring, we used a task that has been effective in revealing individual differences in source monitoring with children (Foley et al., 1983; Johnson & Foley, 1984), with adults differing in field dependence (Durso, Reardon, & Jolly, 1985), and with clinical populations (Harvey, 1985). This task permits a direct comparison among various source monitoring conditions, with materials held constant.

In this task, subjects were presented with a list of words originating from different sources. There were four different acquisition conditions. In the say–listen (internal–external) condition, subjects were asked to say some words aloud and to listen while an experimenter said other words aloud. In the think–listen (internal–external) condition, subjects were asked to imagine themselves saying some words and to listen while an experimenter said other words. In the say–think (internal–internal) condition, subjects were asked to say some words aloud and to imagine themselves saying other words, and in the listen–listen (external–external) condition, subjects were asked to listen while two experimenters said words aloud. Subjects in all of the conditions were then given a surprise memory test in which they were asked to indicate the source of the item. For example, in the say–listen condition, subjects were asked whether each word was one they had said, one they had heard the experimenter say, or a new word. The say–listen and think–listen conditions were included to determine whether older adults have problems in discriminating between externally derived and internally generated memories, and the say–think and listen–listen conditions were included to examine the ability of older adults to discriminate between two internal and two external sources, respectively.

If older adults have a general deficit in source monitoring, their discrimination performance should be poorer than that of younger adults by about the same amount in all conditions. Differences in age deficits among the various conditions, however, would indicate a more selective disruption of source monitoring processes with age. On the basis of the reality monitoring model, we might expect age deficits to be greater in the say–think and listen–listen conditions than in the say–listen and think–listen conditions because within-class discriminations should tend to be more difficult than between-class discriminations.

Method

Design and Materials

The design was a 2 × 4 factorial with age (younger adults and older adults) and condition (say–listen, think–listen, say–think, and listen–listen) as between-subject variables. A total of 16 subjects were tested in each condition.

The materials consisted of 60 nouns with frequencies of 30–40 occurrences per million selected from the Thorndike-Lorge (1944) word count. One half of the words were randomly designated as the target list, and the remaining half served as the new (distractor) list for a later memory test. Within the target set, 15 words were assigned to each of the two types of items (e.g., 15 S items and 15 L items in the say–listen condition). The words were counterbalanced such that across subjects each word appeared equally often as a target and a distractor. When a word was a target, it appeared equally often as one of the two types of items.

At study, the target words were presented randomly with the restriction that no more than three items of each type were presented successively. Similarly, at test, the order of presentation was determined by randomly assigning the items to the 60 positions with two restrictions: (a) The words from the beginning and the end of the study list were not placed first or last on the test list, and (b) no two words that were adjacent on the study list were presented successively on the test list.

Participants

A total of 64 younger adults (35 women and 29 men) and 64 older adults (38 women and 26 men) participated in this experiment. The younger adults were undergraduate and graduate students at George Washington University, who received course credit or payment for their participation in the experiment. The older adults were community-dwelling residents from the Washington, DC area, who were solicited through advertisement and received payment for their participation. They were in good health (self-report) and apparently were free from sensory difficulties or had corrected vision and hearing. The mean age of the younger group was 19.5 years (range = 18–25 years), and the mean age of the older group was 69.4 years (range = 60–80 years).

The mean number of years of education were 14.2 (SD = 1.04) for the younger adults and 15.7 (SD = 2.29) for the older adults. A 2 × 4 analysis of variance (ANOVA), with age and discrimination condition as variables, showed that there was a main effect of age, $F(1, 120) = 22.30$, $MS_e = 3.16$, but no main effect of condition, $F < 1$, and no interaction, $F(3, 120) = 1.04$. Thus, older adults were more educated than younger adults, but years of education did not differ across the experimental conditions.

All of the subjects completed the Vocabulary subtest of the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981). The mean scores were 52.59 for the younger adults (SD = 5.99) and 58.72 (SD = 5.66) for the older adults. A 2 × 4 ANOVA, with age and discrimination condition as variables, showed a main effect of age, $F(1, 120) = 34.60$, $MS_e = 34.69$, no main effect of condition, and no interaction between age and condition (both $Fs < 1$). Thus, although the WAIS-R scores were significantly higher for older adults, they did not differ across the experimental conditions.

Procedure

Each subject was tested individually. All of the subjects received an acquisition list, followed by a source monitoring test and the WAIS-R Vocabulary test.

The acquisition list was presented at the rate of 4 s per item. As in most previous studies of source monitoring (e.g., Foley et al., 1983), subjects were not warned about the memory test. They were instructed to pay close attention to the items and were told that the purpose of the experiment was to provide control data from adults to compare with a study designed for children.

At acquisition, in all conditions, each word was "experienced" twice. That is, the primary experimenter read each word aloud and indicated who (or how) it was to be said next. The primary experimenter and assistant(s) were female graduate and undergraduate students. There were four practice trials before the main list was presented. All of the words were spoken in a loud and clear fashion to ensure that older adults would not have difficulty in hearing them.

In the say–listen condition, in addition to the primary experimenter, there was an assistant present in the room. Subjects were asked to repeat out loud some of the words said by the experimenter, and they were asked to listen carefully while the assistant repeated other words out loud. In the think–listen condition, there was also an assistant present. Subjects were asked to think of themselves repeating out loud some of the words said by the experimenter, and they were asked to listen to the assistant repeating other words out loud. When instructed to think of the words, subjects were told to imagine themselves actually saying (covertly pronouncing) the words out loud. After the four practice trials, subjects were asked to describe what they did when thinking of the words. If they responded incorrectly (e.g., I imagined a "boot"), then the instructions were repeated to emphasize that they should actually think of saying the words out loud to themselves. In the say–think condition, subjects were asked to repeat out loud some of the words said by the experimenter, and they were asked to think of themselves repeating other words out loud. The instructions for *think* words were identical to those in the think–listen condition. Finally, in the listen–listen condition, there were two assistants present. The primary experimenter asked the first assistant to repeat some words out loud and asked the second assistant to repeat others. Subjects were instructed to listen carefully to the two assistants.

Following the acquisition phase, a source monitoring test was presented. Most subjects in both age groups appeared to be surprised by this test. Subjects in all of the conditions were given a test booklet with 60 words. They were asked to record their responses by circling an appropriate letter beside each word. In the say–listen condition, subjects were asked to decide whether the word was one that they said (letter S), one that they heard (letter H), or a new word (letter N). For the think–listen condition, subjects circled letter I (imagined), letter H (heard), or letter N (new), and for the say–think condition, they circled letters S, I, or N. Finally, in the listen–listen condition, subjects circled E_1 (Experimenter or Assistant 1), E_2 (Experimenter or Assistant 2), or N (new word).

The source monitoring test was self-paced, and no subject required more than 5 min to complete the test.

Results

Source Monitoring Scores

The source monitoring (or discrimination) scores are shown in Table 1. This measure has been used in other studies of source monitoring (e.g., Finke, Johnson, & Shyi, 1988; Foley et al., 1983; Raye & Johnson, 1980). To obtain these scores, 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. For example, in the say–listen condition, the source monitoring score refers to the number of words correctly identified as items the subject said (S items), plus the number of words correctly identified as items the assistant said (L items), divided by the total number of words correctly identified as old. The significance level was set at .05 for all of the statistical analyses reported in this article, unless otherwise specified.

Table 1
Source Monitoring Scores for Younger and Older Adults

	Younger adults		Older adults	
Condition	*M*	*SD*	*M*	*SD*
Say–listen	.87	.13	.85	.12
Think–listen	.89	.10	.83	.13
Say–think	.89	.08	.74	.14
Listen–listen	.70	.15	.53	.19

An overall 2 × 4 ANOVA with age (younger and older adults) and condition (say–listen, think–listen, say–think, and listen–listen) showed a significant effect of age, $F(1, 120) = 17.67$, $MS_e = 0.018$, and a significant effect of condition, $F(3, 120) = 24.06$. The interaction of age and condition was marginally significant, $F(3, 120) = 2.41, p < .07$. Further analyses comparing source monitoring scores for younger and older adults showed that the age difference was significant for the say–think, $F(1, 30) = 12.77$, $MS_e = 0.013$, and the listen–listen, $F(1, 30) = 8.48$, $MS_e = 0.030$, conditions. In contrast, the age difference in the say–listen, $F < 1$, and think–listen, $F(1, 30) = 2.23$, $MS_e = 0.014$, conditions was not significant. These results clearly indicate that older subjects have particular difficulty in within-class discriminations but seem to have no trouble in between-class discriminations. A further 2 × 2 ANOVA comparing the two combined within-class discrimination conditions with the two combined between-class discrimination conditions confirmed these findings; the interaction of age and condition was significant, $F(1, 124) = 5.12$, $MS_e = 0.023$.

A 2 × 2 ANOVA comparing only the two within-class discrimination conditions (say–think and listen–listen) revealed a main effect of age, $F(1, 60) = 19.40$, $MS_e = 0.021$; a main effect of condition, $F(1, 60) = 31.02$; but no interaction between age and condition, $F < 1$. Thus, overall performance in the listen–listen condition was lower than performance in the say–think condition. However, compared with younger adults, older adults seemed to have equal difficulty with the within-class conditions regardless of whether the source of information was internal or external.

Older adults performed similarly in the two between-class discrimination conditions (say–listen and think–listen). It is noteworthy that older adults could discriminate between internally generated and externally derived memories even when the internally generated word was not overtly expressed. This finding indicates that older adults have no general difficulty in discriminating memories of covert or imagined events from other types of memories. If there were such a deficit, performance in the think–listen condition would be worse than performance in the say–listen condition. Therefore, the problem that older adults had in the say–think condition reflects some special difficulty discriminating memories of covert from memories of overt self-generated events.

Old–New Recognition

To index recognition of old and new items without regard for correct identification of the source, *d'*s were computed. Recognition was higher for younger subjects ($d' = 2.62$) than for older subjects ($d' = 2.24$), $F(1, 120) = 8.78$, $MS_e = 0.50$. There was also a main effect of condition, $F(3, 120) = 6.90$. The *d'* scores were as follows: say–listen (2.39), think–listen (2.41), say–think (2.87), and listen–listen (2.06). The interaction of age and condition was not significant, $F < 1$. Newman-Keuls tests indicated that performance in the say–think condition was superior to all the other conditions.

In the say–think condition, subjects generated all words either overtly or covertly, whereas in the other conditions subjects generated either half or none of the words. The higher overall recognition performance in the say–think condition might be due to superior memory for self-generated information (Slamecka & Graf, 1978). This finding is consistent with other studies that have demonstrated superior memory for generated information in older adults (McFarland, Warren, & Crockard, 1985; Mitchell et al., 1986). Note, however, that in the present experiment, subjects first heard a word and then "generated" it by saying it overtly or covertly. In Slamecka and Graf (1978) and other similar studies, subjects were not presented with whole items. Rather, they were asked to generate items according to certain rules.

Recognition of Different Types of Items

The mean number of recognition hits for different types of items is shown in Table 2. Both younger and older subjects in the say–listen condition had a greater number of hits for S (say) items than for L (listen) items, $F(1, 30) = 27.90$, $MS_e = 3.67$. Likewise, in the think–listen condition, hits were higher for T (think) items compared with L (listen) items, $F(1, 30) = 36.76$, $MS_e = 3.52$. Because both S and T items are "generated," superior performance on these items is consistent with the generation effect.

In the say–think condition, there was no main effect of type of item, $F < 1$. Similarly, in the listen–listen condition, there was no significant effect of type of item, $F(1, 30) = 2.87$, $MS_e = 1.76$.

False Positives

Johnson and Raye (1981) noted that there is a general tendency in making self–other discriminations to attribute new

Table 2
Mean Number of Recognition Hits for Each Type of Item

	Younger adults		Older adults	
Condition	*M*	*SD*	*M*	*SD*
Say–listen				
Hits for S items	13.44	1.32	12.69	2.94
Hits for L items	11.13	2.22	9.94	3.47
Think–listen				
Hits for T items	13.69	1.49	13.13	2.39
Hits for L items	11.38	1.93	9.75	2.32
Say–think				
Hits for S items	12.94	1.39	11.75	2.11
Hits for T items	12.93	1.61	11.44	2.73
Listen–listen				
Hits for L_1 items	12.56	1.86	11.00	2.48
Hits for L_2 items	12.06	1.95	10.38	2.80

Table 3
Mean Number of False Positives for Each Type of Item

Condition	Younger adults *M*	Younger adults *SD*	Older adults *M*	Older adults *SD*
Say–listen				
New items called S	0.75	1.13	0.69	2.02
New items called L	2.31	2.39	2.69	3.46
Think–listen				
New items called T	0.44	0.73	0.94	1.53
New items called L	2.25	3.15	2.44	2.42
Say–think				
New items called S	0.31	0.60	0.69	1.40
New items called T	0.63	0.89	0.75	1.13
Listen–listen				
New items called L_1	1.69	1.70	2.25	2.15
New items called L_2	2.38	2.42	2.06	1.88

items to others. For example, Foley et al. (1983) found that in their say–listen condition, younger adults were more likely to misidentify a new item as one they heard rather than said. We found a similar bias in both the say–listen and think–listen conditions in the present experiment (see Table 3). A 2 × 2 ANOVA for each condition with age and type of error (new items attributed to the assistant vs. new items attributed to self) showed that subjects were more likely to mistakenly identify a new item as an L item rather than an S item, $F(1, 30) = 14.51$, $MS_e = 3.50$, or as an L item rather than a T item, $F(1, 30) = 12.28$, $MS_e = 3.57$. In the say–think and listen–listen conditions, there was no bias to attribute the new items to either source (both $Fs < 1$).

Overall, the false positives show that older adults use at least some of the same decision rules as younger adults. In attributing an item to a particular source of information, both groups may believe that they have better memory for what they say or think than what they hear. Therefore, when an item seems only vaguely familiar they attribute it to the external source.

Discussion

The results of this experiment clearly indicate that older adults have a specific rather than a general deficit in remembering the source of information. There was no age deficit when subjects had to discriminate what they said from what they heard another person say (say–listen) or when they had to discriminate what they thought from what they heard another person say (think–listen). However, the discrimination performance of older adults was lower than the performance of younger adults when subjects had to discriminate words they said from words they thought (say–think) or words one person said from words another person said (listen–listen). Thus, with the materials used here, older adults did not have any special difficulty discriminating between the general classes of internally generated and externally derived memories (reality monitoring). In contrast, older adults showed marked deficits in discriminating between two memories of the same class (external and internal source monitoring). It should be emphasized, however, that age deficits in source monitoring would not necessarily be limited to within-class discriminations. As noted earlier, if the external and the internal sources are very similar on a number of dimensions, then there might be an age difference in reality monitoring as well.

According to the reality monitoring model, age deficits in source monitoring may occur for at least two reasons. First, older adults may have difficulty using the critical information dimensions that discriminate between memories (e.g., sensory information, cognitive operations). Second, there might be an age deficit in reasoning or judgment processes. The absence of an age by type of false positive interaction suggests that the age deficit in discrimination was not due to faulty reasoning or judgment processes. It appears that both younger and older subjects assume that self-initiated information is more memorable than externally derived information and, thus, when they falsely recognize a new item as old, they are more likely to attribute it to the external source (L item) than to themselves (S item or T item). To the extent that false positives reflect metamemory assumptions, the present results are consistent with other findings regarding metamemory in older adults. Although there is some evidence that suggests an age deficit in metamemory (Bruce, Coyne, & Botwinick, 1982; Murphy, Sanders, Gabriesheski, & Schmitt, 1981), most studies have failed to find age differences (Lachman, Lachman, & Thronesbery, 1979; Rabinowitz, Ackerman, Craik, & Hinchley, 1982; see Cavanaugh & Perlmutter, 1982, and Salthouse, 1982, for reviews).

It is more likely that the age deficit in source monitoring is due to a failure in remembering the information from dimensions that potentially differentiate the source of memories. Several studies have reported age-related deficits in remembering sensory aspects (Kausler & Puckett, 1980, 1981a, 1981b), spatial/temporal attributes (Kausler, Lichty, & Davis, 1985; Light & Zelinski, 1983; Moore, Richards, & Hood, 1984; Park, Puglisi, & Lutz, 1982; Perlmutter, Metzger, Nezworski, & Miller, 1981; Pezdek, 1983), and semantic details of information (Craik & Simon, 1980; Hess, 1984; Rabinowitz & Ackerman, 1982; Rabinowitz, Craik, & Ackerman, 1982). In addition, although at present there is no direct evidence indicating that older adults have poor memory for their cognitive operations, there is some evidence suggesting that older adults may not spontaneously engage in cognitive processes such as elaboration (Craik, 1977, 1984; Craik & Byrd, 1982; Craik & Simon, 1980), organization (Hultsch, 1969, 1974; Sanders, Murphy, Schmitt, & Walsh, 1980), and production of mediators (Hulicka & Grossman, 1967). To the extent that these memory attributes contribute to discriminating the source of information, age-related deficits in using any or all of these attributes may lead to a failure in source monitoring.

The particular pattern of source monitoring deficits that we obtained provides a clue about which dimensions may contribute to the age deficit in source monitoring in the present situation. With verbal materials, the presence or absence of information about cognitive operations may be an especially salient cue for reality monitoring (Raye, Johnson, & Taylor, 1980). The fact that older adults did not have difficulty in the say–listen and think–listen conditions suggests that they can use those cues as well as younger subjects. In the say–think condition, the cognitive operations involved in saying and thinking should be very similar, thereby reducing the effectiveness of cognitive operations as a cue to the source. Presumably, subjects then have to rely either on memory for the presence or absence of kinesthetic information, or on memory for specific sensory information about voice quality. In this situation, older adults seem to have difficulty in discriminating the source. Similarly, discrimination in the listen–listen condition should also depend on evaluating sensory information such as specific voice quality. Again, older adults have difficulty in this condition. Thus, sensory/perceptual information may be particularly important in conditions in which older adults had the most trouble.

The pattern of findings, then, suggests that there are greater age deficits in remembering sensory/perceptual aspects of memories than self-generated or "reflective" aspects (Johnson, 1983). Older adults may be less likely than younger adults to engage spontaneously in reflection, but if they do, the present results indicate that they are not at a disadvantage in later using information about cognitive operations as a cue to the source of information. Furthermore, the present results suggest that whether older adults will show a deficit in source monitoring may depend on the relative importance of sensory and cognitive operations information in specifying the source of a memory.

McIntyre and Craik (1987) have suggested that to specify further the nature of source forgetting it is necessary to vary systematically the salience of various types of information present in a learning episode. Extending the reality monitoring model to the more general problem of source monitoring (Johnson, 1988; Lindsay, 1987; Lindsay & Johnson, 1987) offers a systematic approach for exploring the salience of various information dimensions used in remembering source information. Future research could be directed at examining potential age-related differences in forgetting of various characteristics of memories (e.g., sensory information, cognitive operations) and the relation between age deficits in these characteristics and source monitoring problems in older adults.

References

Bruce, P. R., Coyne, A. C., & Botwinick, J. (1982). Adult age differences in metamemory. *Journal of Gerontology, 37,* 354–357.

Burke, D. M., & Light, L. L. (1981). Memory and aging: The role of retrieval processes. *Psychological Bulletin, 90,* 513–546.

Cavanaugh, J. C., & Perlmutter, M. (1982). Metamemory: A critical examination. *Child Development, 53,* 11–28.

Craik, F. I. M. (1977). Age differences in human memory. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 384–420). New York: Van Nostrand Reinhold.

Craik, F. I. M. (1984). Age differences in remembering. In L. R. Squire & N. Butters (Eds.), *Neuropsychology of memory* (pp. 3–12). New York: Guilford Press.

Craik, F. I. M., & Byrd, M. (1982). Aging and cognitive deficits: The role of attentional resources. In F. I. M. Craik & S. E. Trehub (Eds.), *Aging and cognitive processes* (pp. 191–211). New York: Plenum Press.

Craik, F. I. M., & Simon, E. (1980). Age differences in memory: The roles of attention and depth of processing. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging: Proceedings of the George Talland Memorial Conference* (pp. 95–112). Hillsdale, NJ: Erlbaum.

Durso, F. T., Reardon, R., & Jolly, E. J. (1985). Self–nonself-segregation and reality monitoring. *Journal of Personality and Social Psychology, 48,* 447–455.

Finke, R. A., Johnson, M. K., & Shyi, G. C. W. (1988). Memory confusions for real and imagined completions of symmetrical visual patterns. *Memory and Cognition, 16,* 133–137.

Foley, M. A., & Johnson, M. K. (1985). Confusions between memories for performed and imagined actions: A developmental comparison. *Child Development, 56,* 1145–1155.

Foley, M. A., Johnson, M. K., & Raye, C. L. (1983). Age-related changes in confusions between memories for thoughts and memories for speech. *Child Development, 54,* 51–60.

Harvey, P. D. (1985). Reality monitoring in mania and schizophrenia. *The Journal of Nervous and Mental Disease, 173,* 67–73.

Hess, T. M. (1984). Effects of semantically related and unrelated contexts on recognition memory of different-aged adults. *Journal of Gerontology, 39,* 444–451.

Hulicka, I. M., & Grossman, J. L. (1967). Age-group comparisons for the use of mediators in paired-associate learning. *Journal of Gerontology, 22,* 46–51.

Hultsch, D. F. (1969). Adult age differences in the organization of free recall. *Developmental Psychology, 1,* 673–678.

Hultsch, D. F. (1974). Learning to learn in adulthood. *Journal of Gerontology, 29,* 302–308.

Johnson, M. K. (1983). A multiple-entry, modular memory system. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 17, pp. 81–123). New York: Academic Press.

Johnson, M. K. (1988). Discriminating the origin of information. In T. F. Oltmanns & B. A. Maher (Eds.), *Delusional beliefs: Interdisciplinary perspectives* (pp. 34–65). New York: Wiley.

Johnson, M. K., & Foley, M. A. (1984). Differentiating fact from fantasy: The reliability of children's memory. *Journal of Social Issues, 40,* 33–50.

Johnson, M. K., & Lindsay, D. S. (1986, August). *Reality monitoring.* Paper presented at the meeting of the American Psychological Association, Washington, DC.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88,* 67–85.

Kausler, D. H., Lichty, W., & Davis, R. T. (1985). Temporal memory for performed activities: Intentionality and adult age differences. *Developmental Psychology, 21,* 1132–1138.

Kausler, D. H., Lichty, W., & Freund, J. S. (1985). Adult age differences in recognition memory and frequency judgements for planned versus performed activities. *Developmental Psychology, 21,* 647–654.

Kausler, D. H., & Puckett, J. M. (1980). Adult age differences in recognition memory for a nonsemantic attribute. *Experimental Aging Research, 6,* 349–355.

Kausler, D. H., & Puckett, J. M. (1981a). Adult age differences in memory for modality attributes. *Experimental Aging Research, 7,* 117–125.

Kausler, D. H., & Puckett, J. M. (1981b). Adult age differences in memory for sex of voice. *Journal of Gerontology, 36,* 44–50.

Lachman, J. L., Lachman, R., & Thronesbery, C. (1979). Metamemory through the adult life span. *Developmental Psychology, 15,* 543–551.

Light, L. L., & Zelinski, E. M. (1983). Memory for spatial information in young and old adults. *Developmental Psychology, 19,* 901–906.

Lindsay, D. S. (1987). *Whence comes this memory?* Unpublished doctoral dissertation, Princeton University.

Lindsay, D. S., & Johnson, M. K. (1987). Reality monitoring and suggestibility: Children's ability to discriminate among memories from different sources. In S. J. Ceci, M. P. Toglia, & D. F. Ross (Eds.), *Children's eyewitness memory* (pp. 92–121). New York: Springer-Verlag.

McFarland, C. E., Jr., Warren, L. R., & Crockard, J. (1985). Memory for self-generated stimuli in young and old adults. *Journal of Gerontology, 40,* 205–207.

McIntyre, J. S., & Craik, F. I. M. (1987). Age differences in memory for item and source information. *Canadian Journal of Psychology, 41,* 175–192.

Mitchell, D. B., Hunt, R. R., & Schmitt, F. A. (1986). The generation effect and reality monitoring: Evidence from dementia and normal aging. *Journal of Gerontology, 41,* 79–84.

Moore, T. E., Richards, B., & Hood, J. (1984). Aging and the coding of spatial information. *Journal of Gerontology, 39,* 210–212.

Murphy, M. D., Sanders, R. E., Gabriesheski, A. S., & Schmitt, F. A. (1981). Metamemory in the aged. *Journal of Gerontology, 36,* 185–193.

Park, D. C., Puglisi, J. T., & Lutz, R. (1982). Spatial memory in older adults: Effects of intentionality. *Journal of Gerontology, 37,* 330–335.

Perlmutter, M., Metzger, R., Nezworski, T., & Miller, K. (1981). Spatial and temporal memory in 20 and 60 year olds. *Journal of Gerontology, 36,* 59–65.

Pezdek, K. (1983). Memory for items and their spatial locations by young and elderly adults. *Developmental Psychology, 19,* 895–900.

Rabinowitz, J. C., & Ackerman, B. P. (1982). General encoding of episodic events by elderly adults. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 145–154). New York: Plenum Press.

Rabinowitz, J. C., Ackerman, B. P., Craik, F. I. M., & Hinchley, J. L. (1982). Aging and metamemory: The roles of relatedness and imagery. *Journal of Gerontology, 37,* 688–695.

Rabinowitz, J. C., Craik, F. I. M., & Ackerman, B. P. (1982). A processing resource account of age differences in recall. *Canadian Journal of Psychology, 36,* 325–344.

Raye, C. L., & Johnson, M. K. (1980). Reality monitoring vs. discriminating between external sources of memories. *Bulletin of the Psychonomic Society, 15,* 405–408.

Raye, C. L., Johnson, M. K., & Taylor, T. H. (1980). Is there something special about memory for internally generated information? *Memory & Cognition, 8,* 141–148.

Salthouse, T. A. (1982). *Adult cognition.* New York: Springer-Verlag.

Sanders, R. E., Murphy, M. D., Schmitt, F. A., & Walsh, K. K. (1980). Age differences in free recall rehearsal strategies. *Journal of Gerontology, 35,* 550–558.

Schacter, D. L., Harbluk, J. L., & McLachlan, D. R. (1984). Retrieval without recollection: An experimental analysis of source amnesia. *Journal of Verbal Learning and Verbal Behavior, 23,* 593–611.

Slamecka, N. J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Human Learning and Memory, 4,* 592–604.

Thorndike, E. L., & Lorge, I. (1944). *The teachers' word book of 30,000 words.* New York: Columbia University.

Wechsler, D. (1981). *Manual for the Wechsler Adult Intelligence Scale-Revised.* New York: Psychological Corporation.

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