Do Justice and Let the Sky Fall

Elizabeth F. Loftus and Her Contributions to Science, Law, and Academic Freedom

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CHAPTER
7

Illusory Recollection in Older Adults: Testing Mark Twain's Conjecture

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Late in his life Mark Twain said: "When I was younger, I could remember anything, whether it had happened or not, but my faculties are decaying now and soon I shall be so I cannot remember any but the things that never happened. It is sad to go to pieces like this but we all have to do it."

In 1997, the authors of this chapter were ignorant of the preceding quote, but we began a project for which the quote serves as an apt abstract. The thrust of the question we asked was whether older adults are more susceptible to illusory memories than are younger adults. If we examine Twain's quote as a scientific hypothesis making three assertions, two parts of it are well established. Younger adults can indeed remember events that never happened and in some situations their levels of false recall can equal levels of accurate recall (Roediger & McDermott, 1995). In addition, the fact that older adults forget more information than younger adults (especially on tests of unaided recall) has been observed in numerous experiments (see Balota, Dolan, & Duchek, 2000, for a review). However, in the late 1990s there was little evidence about the last part of Twain's conjecture: Are older adults more susceptible to memory illusions than younger adults?

In making predictions about this issue, one could make a strong argument either way—that older adults would be more prone to illusory memories or that they would be less prone—as is so often true in psychology. For example, in making the case that older adults are more likely to suffer from illusory memories, we could point to the well-documented source-monitoring difficulties in older adults (e.g., Henkel, Johnson, & De Leonardis, 1998; McIntyre & Craik, 1987). Given this tendency, older adults might be more likely to mix up the order of events and confuse events, and therefore suffer more illusions of memory than younger adults, all else being equal. On the other hand, one needs to remember *something* in order to have a false memory; in order to have source confusions, one must remember information from more than one source. Perhaps older adults remember events so poorly that they will not show the illusions of memory that younger adults show (or they will show them only in diminished form). A study of certain types of memory-impaired patients reviewed later indicates that these patients do not show the levels of illusory memories that age-matched controls show, so it may be that whatever factors encourage normal levels of retention are also responsible for memory illusions (Schacter, Verfaellie, & Pradere, 1996).

Before launching into the substance of our chapter, we might pause a moment to marvel at the fact that at the turn of the millennium there was so little evidence about memory illusions in older adults. The renaissance of studies of illusory memories began in the early 1970s, and one important stream of this research was initiated by Elizabeth Loftus, the honoree of this volume. In 1974, she published her famous study with John Palmer that began decades of work on eyewitness memory and the misinformation effect (Loftus & Palmer, 1974). This paradigm and others (e.g., Bransford, Barclay, & Franks, 1972) have been the objects of study for many years and we have learned much from them. An overlapping line of research on illusory memories in young children used some of these paradigms and other adaptations (see Ceci & Bruck, 1995, for a review). This research was driven in part by the many court cases of alleged childhood sexual abuse (in day-care centers and other situations). As a population of interest, children have been frequently studied. Older adults, on the other hand, have not been studied, at least until recently. This is surprising because older adults are disproportionately susceptible to crime and must frequently testify, so it is unclear to us why researchers studying memory and aging expended so little of their energies in studying this topic. Of course, there were occasional experiments published that are relevant, a few even dating to the 1970s (e.g., Rankin & Kausler, 1979). Still, there was no systematic program of research in the many laboratories directed at illusory memory processes in older adults, unlike the booming interest in illusory recollection in children and in young adults. It is heartening that the situation is different today than from even a few years ago. Many researchers besides us are studying illusory memories in older adults (e.g., Memon & Bartlett, 2002; Norman & Schacter, 1997; Searcy, Bartlett, & Memon, 1999, 2000).

This chapter reports progress we have made in our own program of research, which was conceived collaboratively in the late 1990s and is still in progress today. We bring in related findings from other labs as needed, but our intent is not to review the literature but rather to provide a summary of our own work with our collaborators (whom we acknowledge along the way). In overview, we report research comparing illusory memories in younger and older adults using four different illusory memory paradigms. These are the Deese–Roediger–McDermott (DRM) associative word paradigm (Deese, 1959b; Roediger & McDermott, 1995), a related categorized word list paradigm (Meade & Roediger, 2006; S. M. Smith, Ward, Tindall, Sifonis, & Wilkenfeld, 2000), the Loftus misinformation paradigm (e.g., Loftus, Miller, & Burns, 1978), and an imagination inflation paradigm in which people confuse imagined actions with ones actually performed (Goff & Roediger, 1998). We review the nature of these paradigms in the coming pages, but in preview we do find elevated levels of illusory recollection in older adults in all four paradigms.

The other focus of our chapter is to consider individual differences among older adults using neuropsychological measures. We know that individual differences are important in all of cognition, and we may suspect that their importance grows as adults age. At the simplest level, measures of variability in all studies of cognitive aging show increases with age, so if individual differences are great among younger adults—and they are—this variability and its importance waxes with age. The primary research strategy used in the field (and in our own prior work) is to compare groups of healthy older adults with younger adults, with them being equated to some degree on other factors. The older adults are usually screened for health risk factors and depression and have equal or higher levels of education relative to younger adults, which controls some variability. In addition, vocabulary scores (a measure of crystallized intelligence or general knowledge) are typically a bit higher in older than younger adults in these studies. Despite these steps, older adults' performance remains consistently more variable than that of younger adults.

In our research, we examined measures that are assumed to assess older adults' frontal-lobe functioning by employing a battery of tasks identified by Glisky, Polster, and Routhieaux (1995). Glisky and her colleagues identified five neuropsychological tests that provide converging measures of frontal functioning. These five tests resulted from a factor-analytic examination of a number of putative frontal tests and other psychometric cognitive/memory tests. The five chosen tests robustly and consistently loaded on a single factor and did not load highly on any other factor. Using a battery of five tests permits more powerful convergent measurement of putative frontal functioning than would be obtained with a single measure (as has been the practice in much neuropsychological research).

The refinement of neuropsychological measures of frontal functioning also permits advances in testing theories of cognitive aging. One prominent theory of cognitive aging attributes older adults' memory difficulties to declining frontal-lobe functioning (Balota, Dolan and Duchek, 2000; Craik, Morris, Morris, & Loewen, 1990; Mather, Johnson, & De Leonardis, 1999; Moscovitch & Winocur, 1995), so using Glisky's battery of frontal tests permits an assessment of whether frontal functioning is critical in memory performance and whether these tests predict recollection of veridical and illusory memories. We used Glisky et al.'s (1995) battery of tests to see if it predicted performance of older adults in the four paradigms we used to study false memories.

ASSOCIATIVE ILLUSORY MEMORIES

Roediger and McDermott (1995) revised a paradigm originally introduced by Deese (1959). Deese (1959a, 1959b, 1965) was interested in associative factors that affect recall and his studies used lists of associatively related words from the Russell and Jenkins (1954) word association norms. The lists were the most commonly listed associates to single words. So, for example, the list of words that were associates to the word *window* were *door, glass, pane, shade, ledge, sill, house, open, curtain, frame, view, breeze, sash, screen,* and *shutter.* Deese (1959b) observed that a few of his lists had a high propensity to elicit recall of the word that had generated (but not appeared in) the list as an intrusion. Other lists created by the same means did not, however, have the same tendency to elicit intrusions. Many years later, Roediger and McDermott (1995) noted Deese's (1959b) observation and developed the paradigm as a means of studying illusory memories. Roediger and McDermott (1995, Experiment 2) developed 24 lists (including some of Deese's lists and others they derived from the norms) that generally produced high levels of false recall, false recognition, and false remembering (using Tulving's [1985] remember/know procedure) in younger adults. The revised paradigm has been frequently studied in the past decade and, as mentioned earlier, is called the DRM paradigm, for Deese–Roediger–McDermott, owing to a suggestion by Endel Tulving. The basic recall results from Roediger and McDermott (1995, Experiment 2) are shown in Figure 7.1 and the recognition results are shown in Figure 7.2.

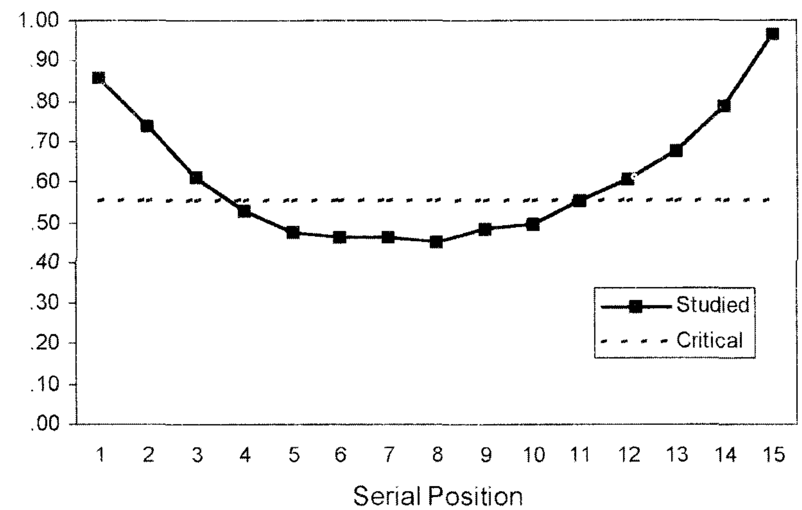

Figure 7.1. Probability of accurate and false recall in the DRM paradigm. The data show a standard serial position curve for the 15 list items, with the strong primacy and recency effects that are standard for single-trial free recall. The datum represented in the dashed line is the probability of false recall of the critical nonpresented items from which the lists were derived. False recall was about at the level of recall of presented items that occurred in the middle of the list. (Data are from Roediger & McDermott, 1995, Experiment 2.)

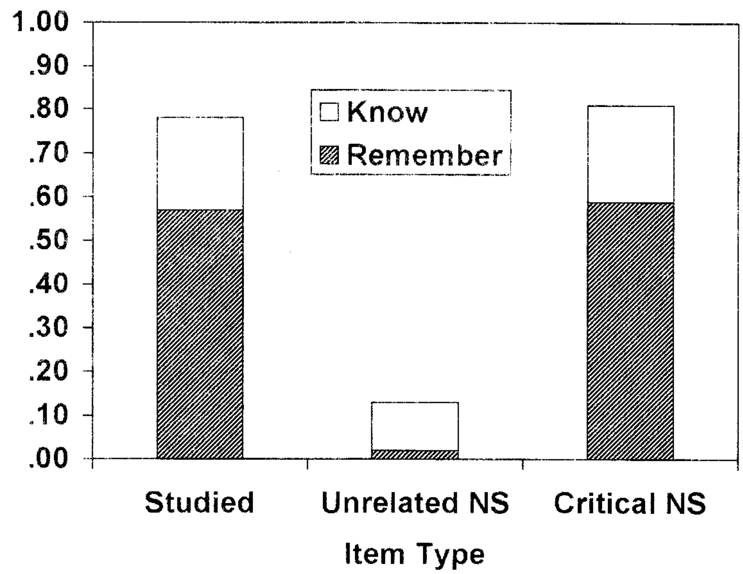

Figure 7.2. Probabilities of recognition in the DRM paradigm. The bars show the hit rate for the studied items and the false-alarm rates for two kinds of nonstudied (NS) items, those generally unrelated to the list words and the critical lure. Each bar is decomposed into the proportion of items judged old to which subjects gave remember or know judgments. The proportions of both false alarms and remember judgments were quite similar for list items and critical lures. (Data are from Roediger & McDermott, 1995, Experiment 2.)

INDIVIDUAL DIFFERENCES IN ASSOCIATIVE ILLUSIONS

Study of individual differences in the DRM paradigm began with an experiment by Schacter, Verfaellie, and Pradere (1996). They tested a group of amnesic patients and matched controls in the DRM paradigm on both veridical recall of list items and false recall of the critical nonstudied items from which the lists had been created. As expected, they found that the memory-impaired patients performed much worse on the list items than did the controls. The interesting finding was that patients also showed much less false recall for the critical items than did the controls. This outcome might indicate that any group of people (children, older adults, depressed people, etc.) or any manipulation that produces poorer retention of the studied items might also show less propensity to elicit false recall or false recognition, which would suggest that occurrence of false memories is necessarily dependent on level of list recall. This assumption was not unreasonable as a starting place in 1996, because experimental manipulations, for example, blocked versus random presentation of several DRM lists, showed a correlation between list recall and false recall. Such as, McDermott (1996) showed that blocked presentation of lists increased both accurate and false recall relative to random presentation of lists. However, this general proposition of a cause-and-effect relation between veridical and false recall was dashed on the shoals of further research. Several experimental manipulations have opposite effects on veridical and false recall, including list length (Robinson & Roediger, 1997), presentation rate (Gallo & Roediger, 2002), and item repetition (McDermott, 1996). Most relevant for present purposes, the same negative correlation between veridical and false recall was reported in an experiment by Norman and Schacter (1997) that compared younger and older adults in the DRM paradigm. They found that older adults recalled DRM lists less well than younger adults (not surprisingly), but they also showed that older adults were *more* likely to falsely recall the critical items. This is exactly opposite the pattern Schacter et al. obtained with amnesic patients. Norman and Schacter's outcome with older adults was confirmed by Balota et al. (1999) and was extended to patients with diseases of the Alzheimer's type. Balota et al. showed greater false recall and false recognition in older adults than in younger adults, as well as greater false memory in dementia of the Alzheimer's type (DAT) patients than in age-matched older adults. However, not all studies have found higher absolute levels of false retention in older adults using the DRM paradigm (e.g., McCabe & Smith, 2002; Tun, Wingfield, Rosen, & Blanchard, 1998), but most do show a higher ratio of false recall/recognition in older adults. Differences in outcome among studies in older adults may be due to varying characteristics of the sample of older adults, an issue that we address later.

Because Balota et al. (1999) employed fairly large numbers of subjects, they were able to match subjects in the various groups on levels of veridical recall and recognition by eliminating some young subjects with the best recall and some older subjects with the poorest recall. When they performed this matched-subjects analysis, they confirmed that older adults showed greater levels of false recall and recognition relative to younger adults. The same analysis held for the comparison of DAT patients and older adults. The data are shown in Figure 7.3. Because frontal-lobe atrophy is thought to occur in older adults and to be accelerated in patients with Alzheimer's disease, these results are consistent with theories that attribute declines in memory functioning in aging to impaired frontal functioning.

Butler, McDaniel, Dornburg, Price, and Roediger (2004) compared younger and older adults in the DRM paradigm. The older adults had been previously tested using Glisky et al.'s (1995) battery of tests so that roughly half were high frontal functioning and half were low frontal functioning, using the criteria of the original Glisky et al. sample. Both groups of older adults scored higher (and equally well) on a standard vocabulary test than did younger adults, and the older adults had been screened for depression and for mental state (using the mini-mental state examination or MMSE). Subjects were given DRM lists for immediate free recall. The results are shown in Table 7.1. The left side of the panel indicates that prior work of Norman and Schacter (1997) and Balota et al. (1999) was replicated. Older adults' recall of list items was worse than that of younger adults (.52 to .61), but their false recall was reliably higher than the younger adults' recall (.42 to .31).

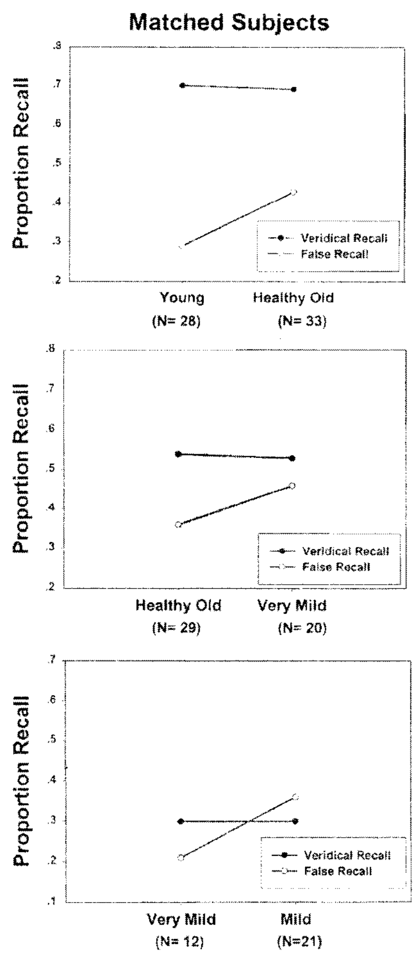

Figure 7.3. Matched-subjects analysis for younger adults, healthy older adults, and two groups of patients with Alzheimer's disease. When matched on veridical recall with a comparison group, the more impaired group always shows a greater level of false recall than the less impaired group. (Data are from Balota et al., 1999.) Reprinted by permission of psychology Press. http://www.psypress.co.uk /journals.asp

The data in the comparison on the left include the entire sample of older adults. The data on the right side of the table decompose the older adults' performance into the high-functioning and low-functioning groups. This analysis makes clear that the "aging effect" seen in the data on the left side of the table is borne entirely by the low-frontal-functioning group. Veridical recall was not significantly different between young and high-functioning older adults and neither was false recall. False recall was about 20% higher in the low-frontal-functioning group than in either the young or the high-functioning old groups.

If these results are replicable and generalize to other paradigms, the implications are profound and highly supportive of the view that cognitive aging is attributable to breakdowns in frontal functioning. Effects attributed to "cognitive aging" by comparing groups of younger and older adults would not be due to "age" per se; if one finds older adults who score highly on tests of frontal functioning (presumably like young adults score) they show neither impaired veridical recall nor increased false recall. Butler et al. (2004) examined scores of putative tests of medial temporal lobe functioning (adopted from the Glisky et al., 1995, factor-analytic study) in many of their older adults and the pattern appearing in Table 7.1 seems to be securely tied to frontal-lobe functioning rather than to some other ability, although further work is needed to bolster this conclusion.

INTERVENTIONS TO ATTENUATE FALSE MEMORY IN LOW-FRONTAL ADULTS

Having found that low-frontal older adults display exaggerated false recall, one of our objectives in our more recent research has been to examine techniques that might attenuate this memory deficit for older adults with low frontal functioning. This work has led to several surprising twists.

One straightforward explanation for the increase in false recall in low-frontal older adults hinges on the observation that the frontal systems seem intimately involved in encoding of source information. In particular, Glisky et al. (1995; see also Glisky, Rubin, & Davidson, 2001) reported that low-frontal older adults showed significant declines relative to high-frontal older adults at remembering perceptual information (gender of speaker's voice) associated with target items. With regard to the Butler et al. finding, the idea here is that perceptual source information from presented words would not be well encoded by low-frontal older adults. Consequently, during recall the low-frontal adults would have few, if any, source features to distinguish presented list items from associatively related nonpresented items that are presumably activated at study (Roediger, Watson, McDermott, & Gallo, 2001) or generated as possible candidates during the recall process (cf. Guynn et al., 2005; Jacoby & Hollingshead, 1990).

One of us (McDaniel), in collaboration with Karin Butler and Courtney Dornburg (Butler, McDaniel, & Dornburg, 2005), reasoned that, in lieu of perceptual source information, perhaps low-frontal older adults could be encouraged to encode distinctive semantic information that would help distinguish target items

Table 7.1
Proportion of List Items and Critical Nonpresented Items Recalled by Younger and Older Adults.[a]

			Frontal Status[b]	
Item Type	Younger	Older	High	Low
List	.61	.52	.57	.46
Critical	.31	.42	.32	.52

Note. Data are from Butler et al. (2004).
[a](left side of the table)
[b]The two columns on the right show recall of older adults decomposed as a function of their frontal status (high or low).

from nonpresented associated items and therefore decrease false recall of the critical associates. McCabe, Presmanes, Robertson, and Smith (2004) developed just such a technique with younger adults. In their study, subjects who were required at encoding to generate a distinctive feature of each presented target word showed lower false recognition than an uninstructed group of subjects. We adapted this distinctive-feature technique for a parallel study conducted with high- and low-frontal-functioning older adults. Because this study has not yet been reported, we provide some of the details.

To more convincingly tie the patterns in recall to frontal functioning (rather than to general neuropsychological health), we also assessed medial temporal functioning (using five psychometric tests from the Glisky et al., 1995 and 2001, battery) for the entire sample of 36 older adults (18 high-frontal and 18 low-frontal). Medial temporal scores were not significantly different across the high- and low-frontal adults (.03 and -.13, respectively). Sixteen college-age adults were also tested. Several procedural changes from that of McCabe et al. (2004) were implemented to accommodate the present objectives. Because the neuropsychological assessment of the older adults was extensive and restricted to older adults with MMSE scores of 26 or higher, the encoding manipulation (standard encoding, distinctive-feature encoding) was varied within subjects. So that the older adults could easily apprehend the target items, we used visual presentations (rather than auditory presentations). To allow older adults time to think of a distinctive characteristic for each target word, we extended the presentation rate to 5 seconds per word (from 4 seconds). A final modification was that in the distinctive-feature condition, we had older and younger adults say aloud the distinctive characteristic they generated in response to each word. We felt that explicit production would make the generated distinctive characteristic of each target more memorable, thereby making it easier for older adults to access that information to help reduce false recall. Explicit production also allowed us to gauge whether older adults were able to implement the strategy.

In the distinctive-features condition, subjects were asked to think of one unique characteristic for each word in the list and to say this characteristic aloud. As an example, subjects were told that upon seeing the word *dog* they might say their dog's name ("Oscar") or upon seeing the word *cat* they might say "allergic" to describe their reaction to cats. Subjects practiced this technique using a list of thematically related words and were given feedback as to how successful they were in generating a unique characteristic to each practice word. Then, for each encoding condition, subjects were given nine DRM lists (blocked by condition), with recall following each list. Several sets of lists were constructed for counterbalancing purposes across each encoding condition, with the sets constructed to produce false recall of approximately .40 on average, according to the Stadler, Roediger, and McDermott (1999) norms.

Table 7.2 shows the false-recall results. Examining the results from the standard encoding condition first (left side), it is apparent that false recall for younger adults was substantially lower than the norms for these lists (.19 vs. .40, respectively). The low level of false recall was probably a consequence of relatively long visual presentations (e.g., see Gallo, McDermott, Percer, & Roediger, 2001; Gallo & Roediger, 2002; Kellogg, 2001; R. Smith & Hunt, 1998). Visual presentations (and longer presentation rates) presumably afford the encoding of perceptual (visual) information that can be used to discriminate between presented targets and nonpresented critical items (which would have little or no visual graphemic information). The idea is that visual information is more distinctive than auditory information in terms of distinguishing targets from nonpresented items (Kellogg, 2001; R. E. Smith, Lozito, & Bayen, 2005).

More important, the high-frontal-functioning older adults also displayed relatively low false recall, and at levels that were not significantly different from that of younger adults. Also consistent with Butler et al. (2004), the low-frontal-functioning older adults displayed significantly higher levels of false recall than the younger adults. For what it is worth, false-recall levels in the low-frontal-functioning group were still lower than the normed level with younger adults (with auditory presentation and a relatively fast presentation rate) of .40 (Stadler et al., 1999). R. E. Smith et al. (2005) reported that visual presentations did not reduce false recall in older adults relative to auditory presentations, but did so for young adults. This finding could be accounted for by the hypothesis that older adults are generally deficient in distinctive processing (R. E. Smith et al., 2005) or in engaging in controlled processes necessary for certain types of distinctiveness to influence retention (Geraci, McDaniel, & Roediger, 2006).

Our new results on the left side of Table 7.2 suggest that, with sufficient processing time, even low-frontal older adults can encode perceptual information that provides distinctive encodings for target items relative to nonpresented associates, and these encodings can successfully be used to reduce false recall. That is, with the current presentation conditions, low-frontal false recall (.29) was not significantly worse than that false recall for high-frontal older adults (.23). Thus, low-frontal older adults appear capable of encoding perceptual source information under favorable conditions and exploiting that perceptual information to avoid memory illusions. Clearly, however, this claim warrants more direct comparison of false recall under auditory and visual presentations for low-frontal adults.

Table 7.2
Proportion of Nonpresented Critical Items Recalled in the Distinctive-Feature Experiment

	Standard Encoding	Distinctive Feature Encoding
Younger (16)	.19	.19
High Frontal Older (18)	.23	.35
Low Frontal Older (18)	.29	.48

Note. Data are from Butler et al. (2005).

The most central and startling result is found in the right-hand side of Table 7.2. False-recall levels *increased* by at least 50%, relative to the standard encoding condition, for both low-frontal and high-frontal older adults, whereas there was no change for younger adults. Unexpectedly, the strategy of attempting to reduce memory illusions in low-frontal older adults by fostering distinctive semantic encoding not only was damaging to the low-frontal adults, but also created conditions under which high-frontal older adults displayed exaggerated false recall relative to the young. The strategy we used to reduce false recall in older adults actually increased errors in both groups, although more for the low-frontal adults.

We had adopted a relatively generous presentation rate to allow older adults to complete the encoding task, but perhaps the rate was still too fast to allow older adults to effectively generate distinctive characteristics. To examine this possibility, we evaluated the responses generated during encoding. On several measures, the older adults' response did not appear significantly different from the younger adults'. The number of trials on which a response was omitted was relatively low for all groups, the proportion of times a critical nontarget item was generated was low, and the proportion of times that the generated response was an associate to the target varied little across groups.

We conclude that the older adults were able to implement distinctive-feature encoding to the same extent as the younger adults. Why then were their memory illusions increased by this encoding technique, one that theoretically and empirically (McCabe et al., 2004) should reduce memory illusions? We cannot say for sure, but several possibilities come to mind. Koutstaal et al. (2003) found that a semantic-labeling orienting task used to encode pictures increased false memories for pictorial materials. They suggested that intentional semantic processing during encoding interfered with perceptual processing that ordinarily would allow discrimination between presented targets and unpresented lures. For the present experiment, it may be that reduced processing resources (or processing speed) of the older adults precluded adequate processing of the perceptual characteristics of the visually presented words when they had to perform the distinctive features task. Consequently, useful perceptual information would be diminished by the distinctive-features task for older subjects.

Another possibility is that the items generated for the distinctive-feature task created additional source-monitoring demands for older adults, who are already challenged by source memory tasks (e.g., Craik et al., 1990; Naveh-Benjamin & Craik, 1995). The idea here is that the words generated for the distinctive-feature task created additional source interference for the older adults because they were faced with three possible sources for candidate items that might be recalled: presented words, words generated during encoding, and nonpresented thematic associates of presented words. Dehon and Bredart (2004) present evidence consistent with this idea. In the next section, we return to this idea that forced responding of extraneous material may be problematic for exaggerating memory illusions, especially in low-frontal older adults. Before doing so, however, we describe another finding that reinforces the emerging picture that the exaggerated memory illusions displayed by low-frontal older adults can be resistant to improvement even under favorable encoding conditions.

Thomas and Sommers (2005) modified the typical DRM procedure so that target words would be more richly encoded with elaborative detail and thus presumably more distinguishable from the nonpresented thematic lures. In the elaborative condition, target words were presented in sentential contexts (e.g., "The weary worker laid down on the bed," with *bed* representing one of the items in the list whose critical lure is *sleep*). With college-age subjects, the sentential contexts significantly improved the discrimination of targets from the critical thematic lures in recognition, primarily by reducing the endorsement of the critical lures. Thomas and McDaniel (2006) examined whether sentence elaboration would similarly reduce false recognition for high- and low-frontal older adults. Table 7.3 displays the endorsement rates for targets and the critical lures and the d′ values for discriminating target items from lures. The findings are dramatic. Both young adults and high-frontal older adults showed substantially reduced false recognition and substantially increased discriminability (d,) with sentence elaboration relative to the standard word-only presentation. In contrast, the low-frontal older adults have nominally *higher* false recognition and *lower* discriminability when the targets are presented in elaborative sentence contexts than when presented in isolation. The upshot of these findings reinforces that found by Butler et al. (2005). Supportive encoding techniques that ordinarily reduce memory illusions can have the opposite effect on older adults, especially low-frontal older adults.

Table 7.3
Proportion of Studied Targets and Critical Lures Endorsed by Younger and Older Adults.

	Younger	Older	
		High Frontal	Low Frontal
Isolated words			
Studied	.73	.65	.62
Critical	.64	.65	.70
d′	.36	-.29	-.83
Sentence contexts			
Studied	.69	.56	.57
Critical	.31	.40	.74
d′	1.58	.75	-1.29

Note. Datat are from Thomas and McDaniel (2006).

Other memory enhancement techniques have also been shown to increase false memories in low-frontal older adults. Dornburg and McDaniel (2006; see Dornburg & McDaniel, 2005, for complete details) reported a related pattern for mnemonic retrieval techniques that is worth mentioning here. Low- and high-frontal older adults (determined by the Glisky et al., 1995, assessment) read a narrative about the courtship of two college students, Bob and Margie. Several weeks later the subjects recalled the narrative either with standard free-recall instructions or with cognitive-interview instructions (Fisher, Geiselman, & Amador, 1989) designed to facilitate recall (e.g., thinking of original encoding context, recalling from different perspectives). Even after a several-week delay, the cognitive-interview technique was successful in significantly increasing recall of information relative to the standard recall condition for both high- and low-frontal older adults. Critically, however, recall of false details increased as well with the cognitive interview for older adults with low frontal scores. That is, the cognitive interview increased production of incorrect information relative to the standard recall condition for low-frontal but not for high-frontal older adults. This pattern appeared to be linked to frontal processes, because medial temporal lobe tests were not correlated with the production of incorrect information.

Taken in concert, the practical implications of the findings described in this section for everyday memory functioning (and possibly for eyewitness memory contexts) are great. Techniques designed to improve memory accuracy and reduce memory illusions may, in some cases, amplify the already exaggerated memory illusions of low-frontal-functioning older adults. Thus, *well-intentioned attempts to* engineer contexts to reduce memory illusions in older adults may unwittingly exacerbate the problem for those adults with low frontal functioning.

We turn next to results in another word list paradigm that has been developed to study false memories to see if the provocative divergence of results as a function of older adults' frontal status will replicate in a somewhat different domain.

ILLUSORY MEMORIES OF CATEGORY MEMBERS

A tactic long used by psychologists interested in the organization of memory is to use items belonging to common categories such as articles of furniture, birds, famous cities, and so on. Bousfield (1953) began the study of how people remember items belonging to common categories and, over the years, a huge number of studies have been done using this technique (see Murphy & Puff, 1982, for a partial review). One problem sometimes noted in this literature is the issue of guessing. If *robin* is presented in the bird category and a person later produces *robin* on a recall test, how can one be sure that *robin* was remembered? Perhaps instead the subject remembered that some birds were on the list and simply produced the first item that came to mind. Robin is the most probable bird to be produced when people are asked to generate members of this category, so it could have been recalled via free association rather than remembering. Tulving and Pearlstone (1966) considered this issue in their famous study of free and cued recall of categorized lists. Their solution was simply to omit the most probable items in a category from the presented members. If a researcher uses less frequent category members (e.g., oriole or even ostrich) presumably subjects are not merely free associating if they recall them on the test (unless they produce a huge number of intrusions). Other corrections for guessing are also possible (Roediger, 1973; Watkins & Gardiner, 1982). However, in retrospect, all these efforts to "correct" for guessing in categorized-list recall (or free recall or even recognition) appear, 40 years later, to be somewhat misguided. In the 1960s, researchers did not find errors to be interesting in their own right—no one was studying false memories—but rather as a source of noise, which needed to be corrected (see Roediger, 1996, for a review). Perhaps when someone produces *robin* while recalling various birds they are really remembering its occurrence, even though the word was not actually in the list. If so, its recollection would have the same status as DRM false-memory errors.

S. M. Smith, Ward, Tindell, Sifonis and Wilkenfeld (2000) used a categorized-list technique to study arousal of false memories. They created lists that omitted the most frequently produced categorized members to examine their intrusion in recall. They showed that the categorized-list paradigm produced false recall similar to that observed in the DRM paradigm, although they did find differences between the two paradigms in priming of nonpresented items on an implicit memory test.

Meade and Roediger (2006) developed a similar paradigm to examine age differences in false recollection in both free and forced recall with younger and older adults. They used 17 items from each category but omitted the first 5. In the category *birds*, subjects studied *crow, bluebird, canary, parakeet, hawk, blackbird, wren, oriole, parrot, pigeon, hummingbird, starling, woodpecker, vulture, swallow, chicken,* and *dove*, items 6 to 22 in the norms. The interest was not only in how well younger and older adults would recall these words in various conditions but also in whether they would recall the five birds that were omitted: *robin, sparrow, cardinal, blue jay,* and *eagle*. Unlike the DRM paradigm, which permits examination of only one possible critical item per list, the categorized list paradigm allows examination of five potential opportunities of false recall (and of course other category items may be intruded).

Meade and Roediger (2006) conducted two experiments, but we report only selected data of Experiment 1 here. After studying the six categorized lists, subjects were given an initial test under either normal cued-recall conditions or under forced-recall conditions. In both cases, they were given the category names one at a time and asked to recall the list items. In the cued-recall condition, they were warned not to guess and were instructed to recall only items from the category that they were reasonably sure had occurred in the list. Under forced-recall conditions, they were told that 20 items had been presented in each category (there were actually only 17) and that they should produce 20 items for each category, guessing if necessary. The subjects were then given a second test.

The results of the first test are shown in Table 7.4. In the cued-recall condition, the data replicated quite well the findings of Norman and Schacter (1997) and

Balota et al. (1999), among others. Older adults recalled more critical items (robin, etc.) than did younger adults, .22 to .09, whereas there was no difference in veridical recall. This last finding is not a real surprise, because on tests that provide strong retrieval cues, often older adults can recall about as well as younger adults, presumably due to greater retrieved support provided by the cues (Craik, 1977). The forced-recall results show much higher levels of production because subjects were required to free-associate and generate appropriate category members. Notice that for the critical items, both older and younger adults produced about 70% of the critical items. This equivalence is critical in interpreting the results on the second test.

The second test was of the most interest. All subjects were tested under cued recall conditions with instructions to recall only items that they were reasonably sure had occurred on the original study list and not to guess. The category names were presented one at a time and subjects had 3 minutes for recall of items from each category. In addition, they were instructed to make a *remember* or *know* judgment on each word recalled, using instructions adapted from Rajaram (1993; see also Gardiner, 1988; Tulving, 1985). Of course, for subjects who had previously taken a cued-recall test, the second test was essentially the same with the addition of remember/know instructions. Our interest was focused on the subjects whose first test had involved forced recall because prior work has shown that forcing subjects to guess on a first test leads them to make more errors on a later test (e.g., Roediger, Wheeler, & Rajaram, 1993; Schooler, Foster, & Loftus, 1988). We also predicted that older adults would have more difficulty in monitoring their responses on the second test and would be more bothered by having created their own retroactive interference in the form of guessed responses on the prior forced-recall test than would younger adults. The prior forced-recall phase should make interfering items come to mind in the cued-recall test and older adults should have more difficulty in ignoring this enhanced fluency. Jacoby (1999) has shown that older adults are more likely to attribute highly accessible items to memory than are younger

Table 7.4
Mean Proportion of Items Recalled by Younger and Older Adults on an Initial Cued Recall or Forced Recall Test.

	Cued Recall		Forced Recall	
	Younger	Older	Younger	Older
List recall:	.39	.39	.65	.59
Critical recall:	.09	.22	.70	.69

Note. From Meade & Roediger (2006), Experiment 1.

adults, even when factors other than prior presentation make the items highly accessible. High accessibility makes people (young and old) more confident that a retrieved item was recently experienced, but the impact of this factor is greater in older adults. Kelley and Sahakyan (2003) have shown that older adults show a lower correspondence between confidence ratings (subjective judgments) and accuracy of recall (objective correctness) than do younger adults (see also Koriat & Goldsmith, 1996).

The results of Meade and Roediger's (2006) second test are shown in Table 7.5 and they bear out these predictions. Recall of list items is shown at the top as a function of whether the first test had been cued recall (on the left) or forced recall (on the right). Once again, older and younger adults did not differ too much in either overall recall or in remember/know judgments, although performance was somewhat higher for both groups following forced recall. The real interest is in critical-item recall, shown at the bottom of the table. A second cued-recall test after a first one produced higher levels of false recall for old than young adults, as shown in the lower left cells of Table 7.5. Furthermore, the effect was one of false remembering because the older adults' *remember* judgments exceeded those of younger adults on the critical items (16% to 6%). The data on the bottom right of the table show the most dramatic finding in the experiment: On the cued-recall test following a forced-recall test, older adults were twice as likely as younger adults to falsely recall the critical items and their false remembering was eight times higher than that of younger adults (.33 to .04). *Know* judgments did not differ between younger and older adults.

Table 7.5
Mean Proportion of Items Recalled and Mean Proportion of Remember and Know Responses on a Second Cued Recall Test.

	Prior Cued Recall		**Prior Forced Recall**	
	Younger	Older	Younger	Older
List Recall				
Total	.48	.43	.51	.51
Remember	.39	.34	.40	.37
Know	.09	.09	.12	.14
Critical Recall				
Total	.17	.28	.32	.60
Remember	.06	.16	.04	.33
Know	.11	.12	.28	.27

Note. From Meade and Roediger (2006), Experiment 1.

These results show that older adults are especially susceptible to interference from their own self-produced responses given on the earlier forced-recall test. (Recall that older and younger adults produced equivalent numbers of responses on that first test.) Comparing the data from the first (forced) and second (cued) recall tests, younger adults reduced responding with critical items from .70 to .32, and although .32 is still a high error rate, younger adults claimed to remember the occurrence of only .04 of the critical items. On the other hand, older adults reduced production of critical items from .69 on the forced-recall test (when they were told to guess) to only .60 on the cued-recall test (when they were told not to guess). Furthermore, the older adults *remembered* .33 of the erroneously produced items, a remarkable level of false remembering. These results add to those of Jacoby (1999; Jacoby, Bishara, Hessels, & Toth, 2005) in showing spectacular levels of false memories in older adults.

The next step in this program of research was to determine if frontal status of older adults (high or low) would be related to illusory remembering in the categorized-list paradigm developed by Meade and Roediger (in press). Roediger, Meade, and Geraci (2006) conducted two experiments on this issue with similar results. We report one experiment here. Younger adults and two groups of older adults (high frontals and low frontals, as classified by Glisky et al.'s [1995] criteria) studied the six 17-item categorized lists used in Meade and Roediger and then took two successive cued-recall tests. On both tests subjects rated their confidence in their responses, so that subjects would place an emphasis on accurate responding; for the same reason, we did not include a forced-recall condition in these experiments.

The results from the experiment are shown in Table 7.6 for both tests for younger and older adults. On the left are shown data comparing younger adults to older adults, with data collapsed across both groups of older adults. The data on the right decompose the older adults' performance by their frontal-functioning status. Examining first the data on the left, it is clear that these results replicate those of Meade and Roediger (2006) in that older adults produce more intrusions of critical items than do younger adults on both tests, and this pattern conceptually replicates the work of others with the DRM paradigm. However, when the data on the right-hand side of the table are examined, it is clear that only the low-frontal older adults are carrying the "aging effect" in false recall. The data of the high-frontal older adults lie within a percentage point or two of the younger adults' data for each of the four comparisons. It is the low-frontal older adults who show somewhat lower veridical recall and much higher false recall than the younger adults. Roediger et al.'s (2006) second experiment replicated these results.

We now have consistent patterns of data from two false-memory paradigms, although the two paradigms are similar (both involve presentation of word lists with false recall or recognition indexed by recall or recognition of words that were not presented). Older adults show greater levels of false recall than younger adults in both paradigms., However, when older adults are divided into high- and low-frontal-status groups, the effects of "age" are more properly seen to involve frontal sta-

Table 7.6
Proportion Recalled of List and Critical Items for Younger and Older Adults on Two Successive Cued Recall Tests[a]

Test 1: Cued Recall			Frontal Status	
	Younger	Older	High	Low
List	.44	.43	.45	.41
Critical	.17	.26	.15	.36
Test 2: Cued Recall				
	Young	Old	High	Low
List	.42	.44	.45	.43
Critical	.18	.32	.16	.47

Note. From Roediger et al. (2005), Experiment 1.
[a]On the right side of the table the older adults' data are decomposed into high- and low-frontal functioning groups.

tus (except for the increase in false recall with distinctive-features encoding in Butler et al., 2005). High-frontal older adults' data resemble those of younger adults and not those of low-frontal older adults. Our next step was to determine if this pattern would hold in a rather different false-memory paradigm.

THE LOFTUS MISINFORMATION PARADIGM

In 1974, this volume's honoree published a study that doubtless changed her life as well as forever altering our field. The Loftus and Palmer (1974) experiments began the study of how eyewitness memory for an event can be molded and reshaped by statements made to or questions asked of a witness after the event had occurred. According to the Web of Science database, that study has been cited over 300 times. A later study by Loftus, Miller, and Burns (1978) that introduced what has come to be regarded as the standard misinformation paradigm has been cited about 450 times. And Beth's great book *Eyewitness Testimony* (published in 1979) has garnered over 800 citations. Yet these remarkable figures actually seem to us to underestimate the impact that her work from the 1970s has had. Every introductory psychology textbook includes discussion of these studies and their implications, as do all cognitive psychology textbooks (and of course human memory textbooks). The eyewitness/misinformation paradigm (like others, such as the obedience studies of Milgram, 1963, or the bystander intervention experiments of Darley and Latane, 1968) is among the classics of modern psychology. Everyone who is a scientific psychologist knows (or should know) this work.

The fact that recollection of a visual event such as observing a crime or a traffic accident can be reshaped by later descriptions of the event (or even questions about the event) has changed the way people regard human memory. The tendency to think of memories as static little bundles of information stored away in the nervous system until some cue would later awaken them and display them before the bright light of consciousness with great fidelity has been thoroughly discredited, although one can still see residual effects of these ingrained assumptions in some theories. The work begun by Loftus and Palmer (1974), as well as other research begun in the early 1970s on constructive aspects of remembering (e.g., Bransford & Franks, 1972; Paris & Lindauer, 1976), firmly established the constructive approach to remembering. Of course, Bartlett (1932) had argued for the same view much earlier, but his evidence was mostly anecdotal and in fact his main finding was never successfully replicated until Bergman and Roediger (1999) did so 67 years later.

Although Beth Loftus's studies of the misinformation effect had a huge impact, with a tremendous number of studies being conducted with young adults and then, somewhat later, with children, relatively few studies have been carried out with older adults. When we wrote our first grant proposal in the late 1990s, we could find only a handful of studies. The first was by G. Cohen and Faulkner (1989, Experiment 2), who found that older adults did show a greater misinformation effect than younger adults. This outcome fits well with the idea that the misinformation effect is due to an error in source monitoring—the misinformation gets mixed up with what originally happened—and that older adults have greater source-monitoring difficulties than younger adults (see Lindsay & Johnson, 1989, for the first point and McIntyre & Craik, 1987, for the second). Although others have replicated this pattern (e.g., Mitchell, Johnson, & Mather, 2003), several studies have found no difference between younger and older adults in incorporating misinformation into memory (Coxon & Valentine, 1997; Gabbert, Memon, & Allan, 2003) and one study even found that younger adults can be more suggestible than older adults (Marche, Jordan, & Owre, 2002). As we noted earlier in the chapter, under some circumstances older adults may not encode and retain the misinformation as well as younger adults and therefore it will have less of an effect.

We began our research to first see if we could find conditions in which older adults would show a greater misinformation effect than younger adults and, if so, whether the effects would be mediated by frontal status of older adults. Roediger and Geraci (2006) conducted two experiments using basic procedures from work by Roediger, Jacoby, and McDermott (1996), who used two slide sequences (ones that had been used in earlier work), rather than the usual one sequence, to gain more power. Younger and older adults saw slide sequences depicting crimes, with the expectation that their memories would be tested for the scenes. In one sequence, a workman pulls a hammer from his toolbox while fixing a chair (and stealing money from a desk), so we will use the hammer as the example item in what follows. After seeing each sequence, subjects read a description purportedly written by another observer (but rich in detail). Some details were right and some were wrong, relative to the original slide sequence. In the inconsistent-information condition, the description referred to the item taken from the toolbox as a screwdriver, whereas in the neutral (baseline) condition the narrative simply referred to a tool.

The subjects later received both yes–no and source-monitoring recognition tests. Roediger and Geraci (2006) obtained the standard misinformation effect in younger adults and found an enhanced misinformation effect in older adults, replicating G. Cohen and Faulkner (1989) among others. Subjects were more likely to recognize screwdriver in the final test following receipt of misinformation in the narrative, and this effect was greater for older than for younger adults. Interestingly, the effect of age also appeared on a source-monitoring recognition test in which subjects were given items such as hammer or screwdriver and then asked whether it had appeared in (a) the slides, (b) the narrative, (c) both the slides and the narrative, or (d) neither the slides nor the narrative. The finding of an age difference in the misinformation effect on a source-monitoring recognition test makes sense in that older adults' source-monitoring abilities have consistently been shown to be worse than those of younger adults.

Roediger and Geraci (2006) conducted a second misinformation experiment, but only with older adults who had been pretested and shown to be high or low in frontal status (again, using Glisky et al.'s, 1995, criteria). Briefly, subjects saw the slide sequences, read a narrative, and received a later source-monitoring test. The design was a 2 x 3 with frontal status (high or low) crossed with consistent, neutral, and misinformation conditions. We added a consistent condition to this experiment in which the narrative correctly referred to items in the original slide sequence, such as hammer for the tool the man pulled from the toolbox (see Loftus et al., 1978). The critical results are shown in Table 7.7, which reports errors on the source test, such as subjects judging the misinformation item (screwdriver) to have actually appeared in the slides for the three conditions (misformation, neutral, and consistent). The data combine errors in which subjects judged the misleading item to be only in the slide sequence or to be in the slide sequence and in the narrative.

Before considering the misinformation effect, we need to address one seeming puzzle in the neutral condition. The baseline error rate of judging the "misinformation" item to have been in the slide sequence is quite high even when a screwdriver had never been presented in the experiment—about 44% overall. This outcome is understandable as the same type of error that occurs in DRM experiments in that the critical item (screwdriver, in this case) is consistent with what subjects saw (a toolbox and items in it). Furthermore, as in the Butler et al. (2004) experiment, low-frontal subjects were more likely to provide a false-recognition judgment (.51) than were high-frontal subjects (.36), thereby providing a replication of the Butler et al. research with pictorial rather than verbal materials. Therefore, at least for these purposes, the data in the neutral condition are quite useful in confirming the prior work in a new paradigm.

On the other hand, the data in the neutral condition create a problem in comparing the misinformation effect in high- and low-frontal subjects because of the dif-

Table 7.7

False Recall of Misinformation Items as a Function of Experimental Condition (Misinformation, Neutral and Control) and Frontal Status of Older Adults (High or Low)

	Frontal Status[a]	
	High	Low
Misinformation	.49	.80
Neutral	.36	.51
Consistent	.36	.32
	Frontal Status[b]	
	High	Low
Misleading—Neutral	.13	.29
Misleading—Consistent	.13	.48

Note. From Roediger & Geraci (2006), Experiment 2.
[a]Proportion errors on the source test in which older adults reported that an item had appeared in the scene in the three conditions.
[b]Misinformation effect as calculated against 2 different baselines

fering baselines. That is, the misinformation effect is based on a difference score between false recognition in the misinformation condition and the neutral (baseline) condition; if performance in the latter condition differs, interpretation of the misinformation effect can become clouded. Somewhat surprisingly, the consistent condition helps to solve this problem, because performance is nearly equivalent for the two frontal groups in this condition. Therefore, the consistent condition provides a good baseline with which to compare the data from the misinformation condition. (For reasons we do not understand, low-frontal subjects benefited from the consistent information in the narrative whereas high-frontal subjects did not.)

The two rows at the bottom of Table 7.7 show the misinformation effect calculated against the two possible baselines (i.e., the difference between false recognition in the misinformation condition to either the neutral or consistent condition). As can be seen there, data using either baseline lead to the same conclusion: Low-frontal subjects showed a greater misinformation effect than did high-frontal subjects, although the effect is much greater if the consistent baseline is used. The results are produced by the remarkably high false-alarm rate for low-frontal subjects in the misinformation condition: .80 false recognition.

Our results using the misinformation paradigm confirm the same patterns obtained in the DRM and categorized-list false-memory paradigms: Older adults are more susceptible than younger adults to illusory memories, and the effect is much greater in low-frontal older adults than in high-frontal older adults. Confirmation of the same basic pattern in the misinformation paradigm suggests a welcome generality to our conclusions, because this paradigm is so different from the other two.

In the next section, we report our attempts to generalize these findings to a fourth paradigm used to study illusory memories.

IMAGINATION INFLATION

Forming mental images is a time-honored way of improving retention (McDaniel & Pressley, 1987; Paivio, 1969) and imagery techniques are included in most mnemonic devices (Roediger, 1980). However, in these cases, people form images of events they want to remember, of true events. What would happen if people were led to form misleading images, if they imagine events that did not happen? Might they come to remember the events as having actually occurred? Raye, Johnson, and Taylor (1980) presented subjects with words or had them generate the words from conceptual clues, and either presentation or generation of the object could occur varying numbers of times. Later, they asked subjects to judge how often they had actually seen the words. Raye et al. found that the internal generation of the words inflated the frequency with which subjects thought they had actually seen the words; the more frequently the word was generated, the greater the effect.

In a more naturalistic paradigm, Garry, Manning, Loftus, and Sherman (1996) asked college students if they had ever experienced rather infrequent events during their childhoods. After subjects made initial judgments, Garry et al. selected items students said they did not remember experiencing and later had the subjects vividly imagine the events. Two weeks later the subjects were again asked to rate the likelihood that the event had occurred during their childhoods. The results showed what the authors called imagination inflation: Imagining the event increased subjects' judgments that the event had occurred, relative to control events that were not imagined. Similar results were reported by Heaps and Nash (1999) and Hyman and Pentland (1996), among others.

These studies used childhood events that, of course, are not under experimental control. The possibility exists (although we believe it unlikely) that the imagination session acted as a retrieval cue on some occasions to prompt subjects to recall actual events from their childhoods. If so, then the second rating by subjects as to whether they had done the event in childhood may have increased because of enhanced accurate recollection of the events in question, not due to imagination inflation.

Goff and Roediger (1998) developed a three-part laboratory procedure designed to examine possible effects of imagination on memory for actions where the potential artifact described previously could not operate. In a first phase, subjects were engaged in the enactment (or subject-performed task) paradigm developed by R. L. Cohen (1981) and Engelkamp and Krumnacker (1980). In an encoding phase, subjects heard commands for action events such as "Push the toy car" or "Break the toothpick" (with the objects provided). Sometimes subjects just listened to the command, sometimes they actually performed the action, and sometimes they imagined performing the action but did not actually do it. In a second, imagination, phase of the experiment, subjects were given a long series of imagination trials with action events; they imagined performing an event either zero (control items), one, three, or five times. Some of these imagined items had occurred during the encoding phase and some had not. Two weeks later subjects received a final test in which they were given action statements (some that had been heard 2 weeks previously and some that had not) and asked to make two judgments: Was the item previously heard and, if so, had they performed it, imagined performing it, or only heard it?

The critical issue of interest in the Goff and Roediger (1998) research was whether repeatedly imagining performance of an action would lead people to believe that they had actually done it. In general, the answer was yes, because the more frequently subjects imagined performing an action, the more frequently they falsely reported having actually performed the action on the later test. The effect across five imaginings was in the 8% to 10% range, but later researchers discovered ways to boost the effect. Thomas, Bulevich, and Loftus (2003) changed the imagination phase from using the general instructions provided by Goff and Roediger (1998) to using specific instructions that encouraged subjects to imagine the action in several modalities—to imagine how the action would feel, how it would look, how it would sound, how it would smell or taste (when appropriate), and so on. Under these conditions, the imagination inflation effect was much larger so that in some conditions people claimed to remember performing an action after repeated imaginings around 25% of the time.

We turn now to an examination of imagination inflation in high- and low-frontal-functioning older adults. Using a somewhat more complicated study procedure than the one used by Goff and Roediger (1998), McDaniel, Butler, and Dornburg (2006) focused more generally on age-related changes in source memory for performed and imagined actions. Both younger and older subjects were presented with action events like those in Goff and Roediger, with the action events either performed or imagined or both. During study, a particular action could be performed one, two, or four times; a particular action could be imagined one, two, or four times; or a particular action could be performed and imagined (once imagined and once performed or twice imagined and twice performed). Two weeks after study, subjects returned to the laboratory to be tested on their retention for the action statements. Verbal descriptions of actions were again presented (but the actions were not performed or imagined); some of them had been previously studied and some had not. Subjects indicated how many times they "did" each described action 2 weeks earlier, and how many times they "imagined" each action (using a response scale ranging from 0 to 8 in both cases). Older adults were characterized as low- and high-frontal-functioning using the same test battery described throughout the chapter.

Of interest were the responses to the actions that had only been imagined and responses to actions that had only been performed (i.e., the actions both imagined and enacted were not included in the following analyses). There are two main memory errors that can be examined in this paradigm. Imagination inflation occurs when subjects indicate that they did an action that they had only imagined, which will presumably increase with the number of imaginings (Goff & Roediger, 1998). Another possible memory illusion in this paradigm is that subjects could indicate they only imagined an action they had actually performed.

Consider first the memory illusion in which subjects indicated that an imagined action was performed—the imagination inflation effect. McDaniel et al. (2006) examined these responses in two ways: (a) The proportion of times that subjects indicated they performed an imagined action at least once (i.e., gave a response of 1–8) was tabulated, and (b) the average number of times the subjects indicated performing an imagined action was tabulated. These scoring procedures converged on a similar pattern; accordingly, we describe the results for only the first measure (see McDaniel et al. for a more detailed report). Older adults were significantly more likely to show imagination inflation; they indicated that they had actually performed an imagined action 41% of the time, whereas younger adults made this error 28% of the time. The effect increased with repeated imaginings for both groups of subjects, replicating Goff and Roediger's (1998) finding with young adults. For actions imagined one, two, and four times, "did" responses were reported for 26%, 37%, and 40% of the items, respectively. However, this increase was not more pronounced for older adults than younger adults. Important to note for present purposes, and unlike the false-memory findings described for the other paradigms we have discussed, low- and high-frontal older adults displayed virtually identical imagination inflation and increases in imagination inflation over repeated imaginings. A more sensitive correlational test of the relation between frontal status and the incidence of "did" responses also found no evidence of an association ($r = -.05$, .09, and $-.04$ for actions imagined one, two, and four times).

For actions that were performed, the false-memory patterns were more complex. Paralleling imagination inflation, with increased number of actual enactments subjects falsely remembered imagining performance of the actions. In contrast to the aforementioned results, older adults were not significantly more likely than younger adults to falsely indicate that a performed action was imagined (38% vs. 33%, respectively). However, within the performance of older adults, low- and high-frontal older adults began to diverge; for actions performed four times low frontals were more likely (over 50% of the time) to indicate the action was imagined than were high frontals (less than 40% of the time). The difference between low- and high-frontal older adults for actions performed four times was also obtained in the scores of the average number of times the subjects indicated imagining the performed action, with low frontals judging the item to be imagined more often (average frequency of .82) than high frontals (.52). In sum, there were generally no age-related differences in falsely remembering that performed actions were imagined. This finding is reliable, because Lee (2001, Experiment 2) reported the same pattern using a similar paradigm. Yet, consistent with the emergent theme of this chapter, in the McDaniel et al. (2006) experiment low-frontal older adults showed an exaggerated imagination illusion relative to high-frontal older adults for the performed actions.

CONUNDRUMS AND CONCERNS

We discuss three issues in this section: Why is it that three paradigms produced a consistent pattern of findings whereas the imagination inflation paradigm produced a somewhat different pattern, inasmuch as high- and low-frontal older adults did not differ in their performance for the imagination inflation illusion? (All four paradigms showed a greater incidence of illusory memories in older than younger adults.) Second, what does it mean to divide older adults into those scoring high or low on frontal tests? Can the dimension really be attributed to frontal functioning or might the differences be due to other individual differences or general cognitive ability? Third, how prevalent are high- and low-frontal subjects in the general populations of older adults that are likely to be tested in typical university settings, where older adults must travel to the campus to be tested?

Regarding the first issue, replication of the imagination inflation results for low- and high-frontal older adults would be useful, and we (McDaniel, Butler, & Dornburg) are in the process of conducting such research. If the pattern holds, it may be that the source memory judgment (judging whether an imagined item was imagined or performed) in the McDaniel et al. (2006) imagination inflation experiment is more difficult than the judgment older adults are required to make in the other paradigms. In the DRM, categorized-list, and misinformation paradigms, retention was tested immediately (in the same experimental session as study) whereas in the imagination inflation experiment performance was tested after a substantial (2-week) delay. Moreover, the study list in the imagination inflation experiments included items presented under both imagine and perform instructions, thereby complicating the subject's source decision with the possibility that an action item could have been both imagined and performed (rather than one or the other). Under these demanding conditions, even high-frontal older adults may not have the capabilities to avoid memory illusions as well as younger adults can. In line with this possibility is the result from the DRM paradigm with the distinctive-feature encoding manipulation (Butler, McDaniel, & Dornburg, 2005). Here, we found that high-frontal older adults were more susceptible to false recall than young adults when the encoding condition created potential interference (with self-generated "distinctive features") but not in the standard encoding condition.

Another possibility is that the memory illusions in the imagination inflation paradigm are mediated by somewhat different processes or neuropsychological systems than the illusions in the other three paradigms. Briefly, McDaniel et al. (2006) hypothesized that when the source of information is central to its content (e.g., the source information refers to a defining feature such as voice or color), then frontal processes will not be correlated with source memory judgments. Only when source information refers to peripheral details will frontal processes mediate recollection of source. In the imagination inflation paradigm, arguably the source of enacting or imagining an event modifies the content—it is part and parcel of the content. That is, the performed action event necessarily takes on additional features including motoric programs involved in enactment, body postures, and kinesthetic feedback (Engelkamp, 2001). In this case, more spontaneous (medial-temporal) processes, rather than controlled frontal processes, may be prominent in subserving source memory (cf. Naveh-Benjamin, 2000). We refer the interested reader to McDaniel et al. for more detailed discussion of this idea.

The second issue, about classification of older adults as a function of frontal status, will likely be better informed as neuroimaging data are brought to bear in examining older adults scoring high or low on the frontal tests. At present, however, it seems safe to say that the test batteries used in our research are not simply dividing older adults into high- and low-functioning individuals. In a number of published studies, as well as some of the newer studies described in this chapter, the group of older adults scoring better on the frontal battery does not score significantly better on average than the low-frontal group on other tests, tests that are thought to tap into medial temporal systems (Butler et al., 2004; Glisky et al., 1995, 2001; McDaniel et al., 1999). Furthermore, the assumption that the high versus low scores reflect differences in frontal neuropsychological systems in particular is supported by the finding that these differences are associated with source memory (a frontal function; e.g., Craik et al., 1990), but not with item memory (Glisky et al., 1995). Indeed, Glisky et al. (1995) reported a double dissociation such that scores on the putative frontal battery were associated with memory for the source of an item (speaker's gender); scores on the putative medial temporal battery were not associated with source memory. In contrast, scores on the medial temporal battery were associated with item memory (recognition of the content of spoken sentences); scores on the frontal battery were not.

Finally, what about the distribution of high-frontal and low-frontal older adults in the population? In a way, this is the wrong question to ask because of course the measure we are using represents a continuous dimension. In addition, samples of older adults may vary widely from lab to lab due to methods of subject recruitment. To gain solid evidence on the possible distribution of frontal measures in older adults one would need to conduct a representative sampling of the population, which we have not done. Nonetheless, we provide some observations here. When we began this research we worried that we might have difficulty finding low-frontal older adults. The reason is that we tested only older adults who were very high functioning. At both Washington University and the University of New Mexico, the older adults tested in memory experiments live in the community, drive to campus for the test, and typically have at least a college degree (and often an advanced degree). Their vocabulary scores are also quite high. Given these facts, we assumed that we were testing very high functioning older adults and that they would mostly be classified as having high levels of frontal functioning on our tests. However, we were wrong. Thus far we have tested several hundred older adults using the Glisky et al. (1995) battery of tests and have consistently found across samples that more of the older adults tested are classified as low frontals when using Glisky et al.'s cutoff scores from their original study. (Glisky's original sample was only 48 subjects and was also composed of generally high-functioning older adults who came to the lab for testing.) We suspect that if it were possible to gain a representative sample of older adults in all settings, we would find a very low proportion of "high-frontal" older adults using Glisky's original criteria. We make this assertion because samples of older adults volunteering for experiments at universities are probably already in the highest ranges of functioning. If more than half of those older adults are classified as low functioning (using Glisky et al.'s criteria), then it seems safe to say that the criteria are very strict and unlikely to generalize well to the population of older adults at large. These concerns highlight the need to consider measures of frontal functioning as a continuum (rather than as categories) and to use correlational and regression techniques to understand the data better. We hasten to add that our studies have generally used both regression analyses and separate group analyses, with similar conclusions derived from both. We have presented analyses using separate groups for ease of understanding.

CONCLUSION

We began the chapter with Mark Twain's quote about aging and memory. We can say now, in retrospect, that he was prescient in his remarks: Our experiments show that all three of his hypotheses are correct. Younger adults can remember events that never happened, just as they can remember ones that did happen; furthermore, aging has dual effects on retention in that older adults are less able than young adults to remember events that occurred in the past, but are more likely than younger adults to remember events that did not happen (or to have illusory memories). Of course, Twain had only hypotheses. Like Twain, we are (now) from the great state of Missouri, which is called the Show Me state. The reason is said to be after a speech given by one of its native sons, Congressman Willard Duncan Vandiver. During a speech at a Navy event in Philadelphia in 1899, he said, "I come from a state that raises corn and cotton and cockleburs and Democrats, and frothy eloquence neither convinces nor satisfies me. I am from Missouri. You have got to show me." We have followed Vandiver's advice and shown through experiments that Twain was right in all essential respects. However, there was one way in which he was wrong. Apparently his conclusions about older adults do not hold for all older adults. Some, those high in frontal functioning, seem to remember much like younger adults in three of our four tasks. We suspect Twain would be happy with this finding, and we also suspect he would have been one of the older adults whose memories were well preserved.

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