Psychological Bulletin
1993, Vol. 114, No. 1, 3-28

0033-2909/93/$3.00

Source Monitoring

Marcia K. Johnson, Shahin Hashtroudi, and D. Stephen Lindsay

A framework for understanding source monitoring and relevant empirical evidence is described, and several related phenomena are discussed: old–new recognition, indirect tests, eyewitness testimony, misattributed familiarity, cryptomnesia, and incorporation of fiction into fact. Disruptions in source monitoring (e.g., from confabulation, amnesia, and aging) and the brain regions that are involved are also considered, and source monitoring within a general memory architecture is discussed. It is argued that source monitoring is based on qualities of experience resulting from combinations of perceptual and reflective processes, usually requires relatively differentiated phenomenal experience, and involves attributions varying in deliberateness. These judgments evaluate information according to flexible criteria and are subject to error and disruption. Furthermore, diencephalic and temporal regions may play different roles in source monitoring than do frontal regions of the brain.

Past experience affects us in many ways. It influences the ease of identifying stimuli under degraded conditions (e.g., Jacoby & Dallas, 1981), changes the probability that we will think certain thoughts (e.g., Dominowski & Ekstrand, 1967; Kihlstrom, 1980), affects emotional responses such as preferences (e.g., Johnson, Kim, & Risse, 1985; Zajonc, 1980), manifests itself as expert or semantic knowledge (e.g., Chase & Simon, 1973; Tulving, 1983), and creates the potential for what we take to be memories of autobiographical events from our personal past (e.g., Rubin, 1986).

This review focuses on expressions of memory that involve judgments about the origin, or source, of information. The term *source* refers to a variety of characteristics that, collectively, specify the conditions under which a memory is acquired (e.g., the spatial, temporal, and social context of the event; the media and modalities through which it was perceived). This concept is closely related to, but somewhat more inclusive than, that of memory for context. A central claim of the source-monitoring approach is that people do not typically directly retrieve an abstract tag or label that specifies a memory's source, rather, activated memory records are evaluated and attributed to particular sources through decision processes performed during remembering.

The ability to identify the source of remembered information is critical for many cognitive tasks. In laboratory studies of memory, for example, it helps subjects differentiate between test items they recognize or recall from a study list and test items that seem familiar or come to mind from other sources. In everyday life, memory for source contributes to our ability to exert control over our own opinions and beliefs; if you remember that the source of a "fact" was a supermarket tabloid such as the *National Enquirer* and not *Consumer Reports,* you have information that is important for evaluating the veridicality of the purported fact. Perhaps most important, the subjective experience of autobiographical recollection—the feeling of remembering a specific experience in one's own life—depends on source attributions made on the basis of certain phenomenal qualities of remembered experience. (When memory information enters consciousness without these qualitative characteristics, it is experienced as knowledge or belief.)

Inability to specify source information can be mildly disconcerting, as in not being able to remember whether the person to whom you are about to tell a joke is the one who told you the joke in the first place. Failures to remember source can also be profoundly disruptive, as in delusions (e.g., Oltmanns & Maher, 1988) and confabulation (e.g., Stuss, Alexander, Lieberman, & Levine, 1978). In fact, a severe disruption in remembering source is a salient feature of some, and perhaps all, forms of amnesia (Hirst, 1982; Mayes, Meudell, & Pickering, 1985).

Source monitoring refers to the set of processes involved in making attributions about the origins of memories, knowledge, and beliefs (Hashtroudi, Johnson, & Chrosniak, 1989; Johnson, 1988a, 1988b; Lindsay & Johnson, 1987; Lindsay, Johnson, & Kwon, 1991). There has been a recent upsurge of interest in such questions (e.g., R. E. Anderson, 1984; Eich & Metcalfe, 1989; Foley, Durso, Wilder, & Freidman, 1991; Hanley & Collins, 1989; Intraub & Hoffman, 1992; Jacoby, Kelley, & Dywan, 1989 Johnson & Raye, 1981; Kahan & Johnson, 1992; Masson,

Marcia K. Johnson, Department of Psychology, Princeton University; Shahin Hashtroudi, Department of Psychology, George Washington University; D. Stephen Lindsay, Department of Psychology, University of Victoria, Victoria, British Columbia, Canada.

Shahin Hashtroudi died on February 24, 1992.

Preparation of this article was supported by National Institute on Aging Grant 1-R01-AG09253. We would like to thank Carol Raye, Sam Glucksberg, Colleen Kelley, Bill Hirst, the 1990–91 crew of the Princeton memory lab (Chad Dodson, Allison Hermann, Tina Loose, Kristi Multhaup, and Carolyn Weisz) and several anonymous reviewers for helpful comments on drafts of this article.

Correspondence concerning this article should be addressed to Marcia K. Johnson, Department of Psychology, Princeton University, Princeton, New Jersey 08544-1010 or to D. Stephen Lindsay, Department of Psychology, University of Victoria, P.O. Box 3050, Victoria, British Columbia, Canada V8W 3P5.

1989; McIntyre & Craik, 1987; Rabinowitz, 1989; Schacter, Harbluk, & McLachlan, 1984; Schooler & Engstler-Schooler, 1990; Schooler, Gerhard, & Loftus, 1986; Slusher & Anderson, 1987; Voss, Vesonder, Post, & Ney, 1987; Zaragoza & Koshmider, 1989), including applications of ideas about source monitoring to a variety of phenomena (e.g., eyewitness memory, persuasion, amnesia, and aging) and the development of special mathematical techniques for analyzing source-monitoring data (Batchelder & Riefer, 1990). Such activity reflects a growing appreciation of the central role that source monitoring plays in cognition. Source monitoring and failures in source monitoring constantly color one's memory for events and influence the development and expression of knowledge and beliefs. In the present article, we describe an integrative theoretical framework for exploring the critical cognitive function of source monitoring and discuss recent empirical work in relation to this framework.

We begin the first section by presenting the basic framework and then reviewing some available evidence for it. In the second section, we examine the relation between source monitoring and a variety of phenomena—such as recognition memory, eyewitness testimony, and the incorporation of fiction into factual knowledge—and illustrate how the source-monitoring framework points to relations among such diverse phenomena. In the third section, we examine the consequences of disruption in source-monitoring processes and discuss the brain regions that are implicated. In the fourth section, we briefly discuss how issues of source monitoring might fit within a more general processing architecture of cognition and memory.

A Source-Monitoring Framework

We build on previously presented ideas about source monitoring (Hashtroudi et al., 1989; Johnson, 1988a, 1991a, 1991b; Johnson & Foley, 1984; Lindsay & Johnson, 1987; Lindsay et al., 1991). A general overview is followed by a discussion of evidence for major points represented in the framework.

Overview

The source-monitoring framework is an extension of the reality-monitoring framework proposed by Johnson and Raye (1981). *Reality monitoring* refers to discriminating memories of internally generated information from memories of externally derived information, such as distinguishing memories for thoughts and imaginations from memories for perceived events. In addition to these *internal-external* discriminations, two other source-monitoring situations are of particular interest: (a) discriminating between externally derived sources (*external source monitoring*), for example, discriminating memories of statements that were made by person *A* from those made by person *B*, and (b) discriminating between internally generated sources (*internal source monitoring*), for example, discriminating memories of what one thought from memories of what one said.[1] According to the present framework, source monitoring of all types is based on characteristics of memories in combination with judgment processes. Among the most important memory characteristics are records of perceptual information (e.g., sound and color), contextual information (spatial and temporal), semantic detail, affective information (e.g., emotional reactions), and cognitive operations (e.g., records of organizing, elaborating, retrieving, and identifying) that were established when the memory was formed.[2]

Source-monitoring decisions capitalize on average differences in characteristics of memories from various sources. For example, compared with memories for imagined events, memories for perceived events tend to include more perceptual, spatial and temporal, semantic, and affective information and less information about cognitive operations. Consequently, a memory with, say, a great deal of visual and spatial detail and very little cognitive operations would be judged to have been externally derived. Decisions may also be made on the basis of a match between the qualities of memories and activated schemas that represent particular sources. For example, if the auditory quality in a memory of a statement matches your idea of (or schema for) Sam's voice, you attribute the statement to Sam.

Many source-monitoring decisions are made rapidly and relatively nondeliberatively on the basis of qualitative characteristics of activated memories (e.g., amount or type of perceptual detail). That is, often we identify the sources of our memories in the course of remembering them, without any awareness of decision-making processes. Sometimes, however, source monitoring involves more strategic processes. Such decisions tend to be slower and more deliberate and involve retrieval of supporting memories, noting or discovering relations, and initiation of reasoning (e.g., "Does this seem plausible, given other things that I know?"). Thus, you might correctly attribute a memory of a conversation to imagination on the basis of the knowledge that you are not acquainted with that person. Or you might attribute a statement to a particular speaker on the basis of general knowledge about them (e.g., "Sam was the only person there who would have said this sort of thing, so he must have said it").

[1] Reality monitoring can be defined in two somewhat different ways (and we have used both). One way emphasizes the self, or internally generated as opposed to externally derived origin of some information. According to this definition, discriminating what one said aloud from what one heard would be classified as reality monitoring, as would discriminating what one only thought from what one heard. The second way emphasizes the covert or nonpublic quality of mental events such as imagination or inference as opposed to the public quality of other events. According to this definition, discriminating what one imagined oneself doing from what one did (here called *internal source monitoring*) would be an instance of reality monitoring. Neither of these definitions of reality monitoring is more obviously correct than the other. The issue is whether in any particular investigation or theoretical analysis, one is emphasizing the self versus external source as *origin* of information or the actual (public) versus imaginal (private) *status* of the information. Our more general point is that there are various types of source discrimination problems and that investigating a variety of them can enrich the understanding of mechanisms that underlie source monitoring. The classification of source-monitoring situations used here is not intended to be final or exhaustive.

[2] Affective information was added to the model later in response to several empirical findings (e.g., Hashtroudi, Johnson, & Chrosniak, 1990; Suengas & Johnson, 1988). For a description of this memory characteristic, see Hashtroudi et al., 1990. Note that these categories of memory characteristics are analytically useful for what are probably "fuzzy set" relations.

Different concepts could be invoked to characterize the nature of these two types of judgment processes. The first has been called relatively "automatic," and the second has been called more "controlled" (Hasher & Zacks, 1979; Norman & Shallice, 1986; Posner & Snyder, 1975; Shiffrin & Schneider, 1977) or "analytic" (Jacoby & Dallas, 1981). The first also has been called more "heuristic," and the second has been called more "systematic" (e.g., Chaiken, Lieberman, & Eagly, 1989). The heuristic–systematic contrast as described by Chaiken et al. comes closest to the contrast that Johnson and Raye (1981) proposed between judgments that are based on qualitative characteristics of activated information (e.g., amount of perceptual information or match to a schema or template) and judgments that are based on more extended reasoning (e.g., retrieving additional information or discovering inconsistencies between what is remembered and what is otherwise known). Chaiken et al. (1989) provided a multifaceted conceptualization of the cognition involved in evaluating information in a persuasion context:

> [Systematic processing is an] analytic orientation in which perceivers access and scrutinize all informational input for its relevance and importance to their judgment task, and integrate all useful information in forming their judgments. . . . When processing heuristically, people focus on that subset of available information that enables them to use simple inferential rules, schemata, or cognitive heuristics to formulate their judgments and decisions. . . . Although . . . systematic processing [is] generally controlled and intentional, the status of heuristic processing is less clear . . . perceivers sometimes use heuristics in a highly deliberate, self-conscious fashion, but at other times they may use heuristics more spontaneously, with relatively little awareness of having done so. (pp. 212–213)

In the source-monitoring framework, both heuristic and systematic processes require setting criteria for making a judgment and procedures for comparing activated information with criteria. For example, heuristic judgments involve criteria such as "if the familiarity level is above *X*, the event probably happened," or "if the amount of perceptual detail exceeds *X*, the event was probably perceived." Criteria for systematic processes might include, for example, limits on the degree of inconsistency between the known and remembered that will be acceptable.

Source judgments are typically made heuristically; systematic processes are engaged less often and tend to be slower and more subject to disruption. Both can provide important checks on each other. For example, systematic processes can, on the basis of implausibility, provide a challenge to memories that, say, passed a heuristic check for reality monitoring because of high vividness. Conversely, heuristic processes can challenge recollections (on bases such as lack of sensory detail) that would otherwise be readily accepted because they fitted with one's general knowledge and beliefs (Johnson, 1988a, 1991a).

Both heuristic and systematic processes involve a range of types of criteria and can be influenced by biases, metamemory assumptions, and current goals and agendas. For example, you might identify a vague recollection as a memory for a previous imagination if you believed that you would remember the event more clearly if it had actually happened. Setting criteria includes a number of important aspects: assigning weights to dimensions that might be used in any given decision (e.g., weighting perceptual information as more important than affective information), assigning confidence to different levels of this weighted information, and assigning particular overt responses (e.g., yes in an old–new recognition task) to specific levels of confidence. For example, one might require a substantial amount of perceptual detail before accepting an experience as a memory of an actual recent event and require less to accept it as a memory of an actual long-ago event. Because source monitoring depends on ongoing goals or agendas, it should be affected by the sorts of motivational and social factors that influence any goal-directed activity. In particular, source monitoring will be done more carefully, with more stringent criteria, under some circumstances than under others. For example, we expect people to be more careful about the origin of information when they are testifying in court than when they are recounting events on a social occasion. What "more careful" means is using both heuristic and systematic judgment processes rather than one type alone and tightening the criteria used.

Source is not an either–or concept. Rather, source can be specified to differing degrees. For example, you may remember that Mary told you a fact and when and where she told you. Or you may only remember that Mary conveyed the information, but not where, or when, or how (e.g., in person, by letter, or by phone). Or you may remember that somebody told you the fact sometime recently but have no idea who. Or you may remember virtually no information about source, as when you recognize someone only as familiar but have no idea when or where you met that person before. According to the current source-monitoring framework, source attributions are made to differing degrees of specificity, with differing degrees of confidence, depending on the information available, criteria used, task demands, and so forth.

Because source monitoring depends on the information available from activated memory records, it relies fundamentally on the quality of the information recorded about events initially. These memory records are the product of the specific perceptual and reflective processes engaged during the initial experience (Johnson, 1983; Johnson & Hirst, 1991; Johnson & Multhaup, 1992). Anything that prevents a person from fully contextualizing information at acquisition (i.e., creating an "event") will reduce encoding of potentially relevant source information. For example, stress or divided attention may disrupt normal perceptual and reflective processes, resulting in relatively impoverished encoded information from which source could be later derived. Similarly, any factors that reduce the likelihood that an event will become embedded in other events should reduce the amount of potentially useful source information. For example, imagine that at a cocktail party you overhear a remark, but the conversation in which you are engaged prevents you from turning to identify the speaker and remembering a related statement made by them earlier, and from considering the implications of this particular person making this remark at a cocktail party. The statement has not been contextualized. In the extreme case, the occasion of overhearing this remark will not become an "event," and you will later have little source-specifying information for the idea expressed. Nonetheless, you might later find the idea familiar or have it come to mind relatively easily as a consequence of this experience.

Because source monitoring depends not only on the quality of the information as encoded but also on the quality of the decision processes when source-monitoring judgments are made, anything limiting these decision processes at test should also disrupt source monitoring. For example, time pressure, severe stress, distraction, or alcohol should decrease people's abilities to engage in reflective processes, particularly relatively deliberate processes (e.g., retrieving related information). Evidence for the dependence of source monitoring on the quality of the information available and the quality of the decision processes applied is discussed in the following sections.

The present framework is in the spirit of Tulving's (1983) call for work on recollective experience: "In theories of episodic memory, recollective experience should be the ultimate object of interest, the central aspect of remembering that is to be explained and understood" (p. 184). He lamented the fact that researchers have "evaded problems entailed in recollective experience" (p. 185). Tulving suggested that recollective experience may range from clear and precise to vague and fuzzy. He speculated that "the subjective feelings of pastness and veridicality of memory must be provided by intrinsic properties of ecphoric information" (p. 187). (*Ecphory* is a hypothetical process by which cues combine with trace information to yield a combined product called *ecphoric information.*) Tulving also noted that considering recollective experience raises the issue of the distinction between memory and decision processes (which in his General Abstract Processing System [GAPS] framework are part of the more general conversion processes that operate on ecphoric information).

Thus, Tulving has emphasized the idea that information is not simply accessed, but combines with cue information in a joint product that is the input to further processing. The source-monitoring framework takes this notion as axiomatic and further attempts to characterize the qualitative nature of this ecphoric product and the factors that enter into its conversion into a feeling of pastness, veridicality, and belief in source. As the following review illustrates, there is less cause to lament than Tulving once had; there is a growing body of research on which to draw in understanding recollection.

In summary, according to the source-monitoring framework, there are at least three important types of source monitoring: external source monitoring, internal source monitoring, and internal–external reality monitoring. In all three situations there are multiple cues to source. We categorized these cues as sensory/perceptual information, contextual (spatial and temporal) information, semantic detail, affect, and cognitive operations. The ease and accuracy with which the source of a memory is identified is determined by several factors: (a) the type and the amount of these memory characteristics included in activated memory records (or in the ecphoric information), (b) how unique these characteristics are for given sources (the more similar the memory characteristics from two or more sources, the more difficult it will be to specify the source correctly), and (c) the efficacy of the judgment processes by which source decisions are made and nature of the criteria used. These attribution processes vary in the extent to which they might be characterized as less deliberative (heuristic) or more deliberative (systematic). In general, source-monitoring attributions should be relatively easy and accurate when the event memory in question is richly detailed, its attributes are uniquely characteristic of its source, and appropriate decision processes and criteria are used during remembering. In the next section, we examine evidence for the approach to source monitoring that we have outlined.

Evidence for the Basic Framework

Role of memory characteristics in source monitoring. Memories for perceived events include more perceptual and contextual information than memories for imagined events, and differences in the amount of these memory characteristics may be used as a basis for reality-monitoring decisions (Hashtroudi, Johnson, & Chrosniak, 1990; Johnson, Foley, Suengas, & Raye, 1988; Johnson, Raye, Foley, & Kim, 1982; Schooler et al., 1986; Suengas & Johnson, 1988). For example, Johnson, Foley, Suengas, and Raye (1988) asked subjects to remember past actual events and past dreams or fantasies and to rate them on a number of memory characteristics. In a separate study, different subjects indicated how they knew that a remembered autobiographical event was real or imagined. Subjects in the first study rated real events as having clearer temporal and spatial information and greater perceptual detail. Subjects in the second study offered such information as evidence that particular remembered events were real (e.g., "[I know it really happened because] I can remember what the dentist's office looked like.").

In addition, confusion between memories of perceived and imagined information increases with decreases in the information about cognitive operations characteristically associated with imagination (Durso & Johnson, 1980; Finke, Johnson, & Shyi, 1988; Foley et al., 1991; Intraub & Hoffman, 1992; Johnson, Finke, Danzer, & Shyi, cited in Johnson, 1991b; Johnson, Raye, Foley, & Foley, 1981; Rabinowitz, 1989). In a study by Finke et al. (1988), for example, subjects' ratings indicated that it was easier to imagine half of a form as complete when the form was symmetrical about the vertical axis than when it was symmetrical about the horizontal axis, suggesting that completing forms about the vertical axis requires fewer cognitive operations than completing forms about the horizontal axis. In a second reality-monitoring study, subjects at test indicated which of a set of whole forms had earlier been shown in complete or incomplete versions. In relation to controls, subjects who had imagined vertical forms as complete had more difficulty in reality monitoring than did subjects who had imagined horizontal forms as complete. This outcome is consistent with the idea that records of cognitive operations can be used to identify oneself as the origin of a memory.

There is also evidence that confusion is increased by perceptual similarity between memories from external and internal sources (Johnson, Foley, & Leach, 1988; Johnson, Raye, Wang, & Taylor, 1979) or between two external sources (Ferguson, Hashtroudi, & Johnson, 1992; Lindsay et al., 1991). In an experiment by Johnson, Foley, and Leach (1988), subjects who had imagined themselves saying some words and had heard a confederate say other words were quite good at later discriminating the words that they had imagined saying from the words that the confederate had actually said. If, however, subjects were asked to imagine hearing the words in the confederate's voice, they had much more difficulty discriminating what they had heard from what they had imagined. Likewise, increasing the semantic similarity between external and internal sources (Johnson et al., 1981) or between two external sources (Lindsay, 1990; Lindsay et al., 1991) increases confusion. Lindsay et al. found that subjects were more likely to misattribute statements made by one speaker to another when the two speakers had described the same events than when they had described different events.

The importance of memory characteristics for source monitoring is also revealed by asymmetries in source-monitoring errors. For example, Belli, Lindsay, Gales, and McCarthy (1992) noted that subjects were much more likely to err by saying that they had seen in a visual event something that they had actually read about in a text describing the event than to err by saying that they had read something in the text that they had actually seen in the visual event (see also Belli, Windschitl, McCarthy, & Winfrey, 1992; Durso & Johnson, 1980). Presumably, reading about an event often gives rise to imagery related to the event, whereas viewing an event is less likely to give rise to imagined reading.

Given that source monitoring is based on qualitative characteristics of memory records, it is especially important that the encoding situation is conducive to engaging in the kind of consolidating and integrative processing that produces the various qualitative characteristics of memories discussed here. In keeping with this, evidence to be presented below indicates that disruption (e.g., from brain damage, aging, and divided attention) in encoding various qualitative characteristics of events results in deficits in source monitoring.

Role of decision processes. Evidence that source monitoring involves decision or attribution processes comes from studies showing that source monitoring depends on the criteria that subjects adopt (Dodson & Johnson, in press; Hasher & Griffin, 1978; Lindsay & Johnson, 1989; Raye, Johnson, & Taylor, 1980). For example, the more times subjects had generated an item during a study phase, the more times they later thought that they had seen it (Raye et al., 1980). However, when subjects were given a limit to their judgment by being asked to use numbers between 0 and 10, the amount of confusion between internally generated and externally presented events was reduced, suggesting that subjects could selectively gate out inappropriate memories with a stricter criterion.

Findings of systematic biases in the source attributions that are made when new items are falsely recognized also support the idea that memories are attributed to sources through decision processes performed during remembering. For example, subjects tend to attribute falsely recognized new items to another's action rather than to their own action, the "it-had-to-be-you effect" (Johnson & Raye, 1981). Source monitoring also improves with the time between a probe and signal to respond (Johnson, Kounios, & Reeder, 1992), with the cues available while making test judgments (Johnson, Kahan, & Raye, 1984), and with full as opposed to divided attention at the time of test (Jacoby, 1991; Jacoby, Woloshyn, & Kelley, 1989; Kelley & Lindsay, 1993; Zaragoza & Lane, 1991). The hypothesis that source monitoring involves both heuristic evaluation of characteristics of memories and more systematic retrieval and reasoning receives support from analyses of source monitoring of autobiographical memories (Johnson, Foley, Suengas, & Raye, 1988), from developmental studies (Foley & Johnson, 1985; Foley, Johnson, & Raye, 1983), and from clinical data on amnesia and confabulation (Johnson, 1991a). We discuss some of these studies in detail below.

Distinguishing among types of source monitoring. The idea that reality monitoring, external source monitoring, and internal source monitoring constitute distinguishable classes of source-monitoring problems that deserve systematic investigation is supported by evidence that poor performance in one situation does not necessarily mean poor performance in another. In one study, for example, older adults were impaired in internal source monitoring and external source monitoring but not in reality monitoring (Hashtroudi et al., 1989). In other studies, young children had particular difficulty in internal source monitoring but not in external source monitoring (Foley & Johnson, 1985; Foley et al., 1983). Harvey (1985) found that thought-disordered manics did not have difficulty in internal source monitoring but that their performance was disrupted in external source monitoring. These and other instances of group differences in source monitoring (Durso, Reardon, & Jolly, 1985; Durso, Reardon, Shore, & Delys, 1991) demonstrate the importance of comparing subjects under a variety of source-monitoring situations.

These patterns of selective deficit should not be taken as evidence that different source-monitoring tasks involve entirely different memory characteristics or judgment processes. However, insofar as different source-monitoring tasks differentially draw on different characteristics of memories (e.g., cognitive operations are ordinarily more important in distinguishing internal from external sources than for distinguishing two external sources), the pattern of deficits across source-monitoring tasks can help us identify which aspects of memories are not being encoded, reactivated, or weighted properly by populations with various source-monitoring deficits.

Evidence from developmental studies of source monitoring. If source is not simply provided by a memory trace but, rather, is a result of relatively complex attribution processes, source-monitoring abilities should develop with age. In fact, young children perform as well as adults in some source-monitoring situations but not in others (Foley, Aman, & Gutch, 1987; Foley et al., 1991; Foley & Johnson, 1985; Foley et al., 1983; Lindsay et al., 1991). For example, Foley and Johnson investigated memories for actions (e.g., "Did you really touch your nose, or did you just imagine yourself touching your nose?"). Compared with adults, 6-year-olds were far more likely to confuse memories of imagining doing and memories of actually doing (internal source monitoring), but they were not more likely to confuse memories of what they had done with memories of what another person had done (reality monitoring), nor did they more often misidentify which of two confederates had performed particular actions (external source monitoring). A similar developmental pattern was obtained for source monitoring of spoken and imagined words (Foley et al., 1983).

Foley et al. (1983; see also Foley, Santini, & Sopasakis, 1989) noted that children had special difficulty in internal source monitoring such as was required for differentiating expressed thoughts or actions from those that were imagined but not expressed (referred to as *realization judgments*). Recent studies suggest that this finding may reflect a more general problem that young children have in coping with similarity among sources. Lindsay et al. (1991) found, across a variety of source-monitoring tasks, that age differences in source monitoring tended to be greater when the to-be-discriminated sources were highly similar. For example, 8-year-old children also had difficulty discriminating actions that they imagined another person doing from actions that they saw that person do (see also Markham, 1991). One idea to be explored is that as sources become more similar on one dimension, other potentially useful source-relevant information becomes more important. Children may have difficulty managing multiple cues to source simultaneously (see also Ferguson et al., 1992). Another possibility is that more difficult source-monitoring problems may be more likely to require more deliberative or extended retrieval and reasoning, the types of processes that develop later (Flavell, 1985).

Earlier studies of source monitoring. Although here we focus on relatively recent work, aspects of source monitoring have been investigated for many years in a variety of contexts: temporal (Underwood & Malmi, 1978) and spatial (Rothkopf, 1971) discrimination, list differentiation (Hintzman, Block, & Summers, 1973; Winograd, 1968), intrusions in recall or false recognition of associates of studied words (e.g., Cramer, 1965; Deese, 1959; Underwood, 1965) or of tacit implications of sentences (e.g., Bransford & Franks, 1971; Corbett & Dosher, 1978; Johnson, Bransford, & Solomon, 1973), intrusions of schema-based knowledge (see Alba & Hasher, 1983, for a review and Hirt, 1990, and M. Ross, 1989, for recent treatments), memory for surface details (e.g., Craik & Kirsner, 1974; Fisher & Cuervo, 1983; Geiselman & Belleza, 1976, 1977; Hintzman, Block, & Inskeep, 1972; Kolers, 1976), and context reinstatement effects (e.g., Eich, 1980; Godden & Baddeley, 1975; Smith, Glenberg, & Bjork, 1978). For example, list differentiation was of interest in attempting to understand interference effects (e.g., Abra, 1972; Winograd, 1968). Studies of list differentiation demonstrated the importance of factors such as semantic similarity and temporal separation of two lists in determining whether subjects could correctly identify the list from which a word came. These findings fit easily within the source-monitoring framework.

Relation to Other Memory Phenomena

In this section, we examine the relation between source monitoring and several different memory phenomena and describe how these diverse phenomena fit within the general source-monitoring framework.

Source Monitoring and Old–New Recognition

From the beginning of our work on source monitoring, we have emphasized that source identification and old–new recognition may draw on different aspects of memories and involve different processes, depending on the specifics of the two tasks (e.g., Johnson & Raye, 1981; Raye, 1976). For example, subject groups may be equated on old–new recognition yet show differences in source-monitoring accuracy, as in the case of comparing different age groups (Ferguson et al., 1992; Foley & Johnson, 1985; Lindsay et al., 1991; Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991) or amnesics and normal controls (Johnson, Hirst, Phelps, Multhaup, & Volpe, 1992; Schacter et al., 1984; Shimamura & Squire, 1991). Recognition scores can be near perfect while source-monitoring performance is at chance (Kahan & Johnson, 1990). Manipulations that affect source-monitoring performance may have no effect on old–new recognition (e.g., Johnson & Raye, 1981; Lindsay et al., 1991), and manipulations that improve recognition may impair source monitoring (Lindsay & Johnson, 1991).

Our claim is not that source monitoring and recognition are two fundamentally different processes. On the contrary, because both the new (nonstudied) and old items on recognition tests are often familiar to the subjects from extraexperimental sources, recognition judgments typically involve some degree of source monitoring (i.e., subjects must attribute memories of studied items to the study list; cf. J. R. Anderson & Bower, 1974). Both source monitoring and old–new recognition can be described within the framework we use for source monitoring, and both can be viewed as drawing on the same family of heuristic and systematic processes.

Thus, the processes involved in recognition and source monitoring are not different at a general level. But across situations both vary in the range and type of information used and in the specific decision processes applied; in a particular experiment, the kinds of memory information and decision processes used to discriminate between old and new items (recognition) may be the same as or different from those used to discriminate among old items from various sources (source monitoring). In the following paragraphs, we explore the similarities and differences in heuristic processes for recognition and source decisions, then discuss the roles of systematic processes in these two types of decisions.

The observed relation between source monitoring and recognition should depend on the extent to which, in a particular situation, they use the same or different information as input. One way of characterizing potential differences among tasks in the input used is shown in Figure 1. The shading in the first panel of Figure 1A indicates that a complex stimulus usually creates a complex pattern of initial activation, including activation attributable to memory records. Different stimuli would give rise to different levels and kinds of initial activation. The second and third panels in Figure 1A show that over the course of a few milliseconds or seconds, activation may become more differentiated, that is, may yield more specific attributes of memory. In connectionist terms, certain activated units might mutually support each other's activation and, hence, cohere or settle into groupings (indicated by squares, circles, and triangles in the second and third panels) that correspond to memory characteristics such as perceptual, contextual, and semantic detail. Increasing differentiation does not refer to an increase of a single type of information (e.g., strength or activation level). A manipulation might, for example, increase undifferentiated activation without increasing differentiation. Different memory characteristics may revive and differentiate at different rates, and activation from some stimuli might asymptote at relatively low levels of differentiation, whereas activation from others might reach high levels of differentiation very rapidly.

Figure 1B represents the idea that different memory tasks have different average differentiation requirements. Identification of degraded stimuli might benefit from activation of rec-

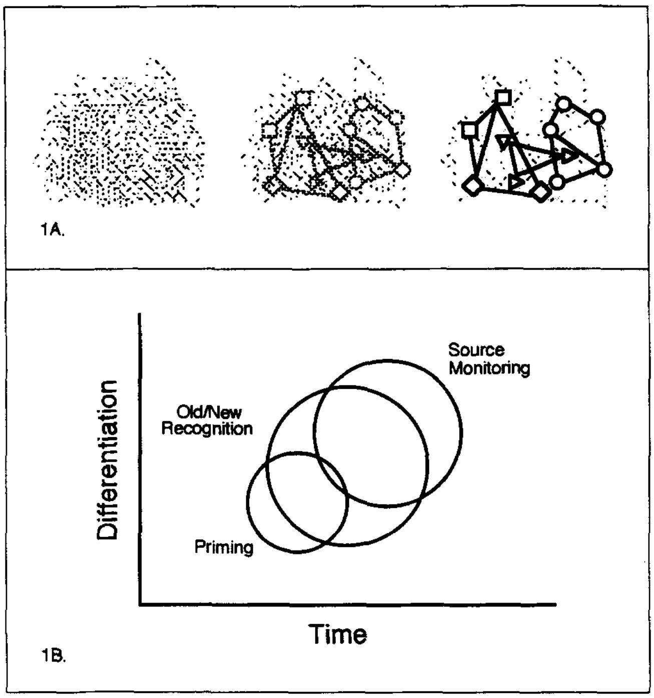

Figure 1. (A) Activation becomes increasingly differentiated, yielding memory characteristics (e.g., perceptual or contextual); (B) Different tasks typically require different degrees of differentiation.

ords of prior exposure (*priming*) whether or not the activation achieves higher levels of differentiation.[3] Old–new recognition typically requires more differentiation than does priming, and source monitoring requires even more so. This is not to say that old–new decisions do not benefit from more differentiated information (as indicated by the overlap in circles designating recognition and source-monitoring tasks in Figure 1B) but simply that they can be made at lower differentiation levels than can source decisions. In general, the phenomenological experience of conscious remembering is associated with higher levels of differentiation, which give memories an eventlike quality.

Recent work by Johnson, Kounios, and Reeder (1992) illustrates the point that source monitoring typically depends on higher levels of differentiation than does recognition. They used a response-signal, speed–accuracy trade-off technique (Dosher, 1984; Reed, 1973; Wickelgren, 1977) to investigate the time course of source monitoring and old–new recognition for previously perceived or imagined pictures. Across one series of experiments, the signal to respond varied from 300 to 1,500 ms after the presentation of a test word. For each test word, subjects were required to indicate whether it corresponded to a previously perceived picture, a previously imagined picture, or a new item. Above chance source monitoring, in this case differentiating memories of perceived from imagined pictures, required more time than did old–new recognition, consistent with the idea that source monitoring typically requires more complete or differentiated information than does recognition. Perhaps even more interesting was that subjects were able to identify the source of imagined items before they could identify the source of perceived items. Assuming that memories for imagined items include more information about cognitive operations and memories for perceived items include more perceptual detail, the pattern suggests that in this situation, information about cognitive operations is more salient or revives more quickly than does information about perceptual detail. We are currently using this technique to explore the rate at which different memory attributes become differentiated.

It is important not to lose sight of the fact that both source and old–new decision processes can be flexibly directed to various points in the revival functions relating various memory characteristics to time. As illustrated by the overlap in the circles in Figure 1B, in any particular situation, the information used for a recognition response could be quite different from (e.g., noting perceptual fluency) or quite similar to (e.g., noting perceptual detail) that used in source monitoring for the same situation. In fact, correlations between source monitoring and recognition vary considerably from situation to situation (e.g., see Craik, 1989), as would be expected if the information each drew on was not fixed but was somewhat flexible and overlapping.

In summary, heuristic source-monitoring processes set decision criteria to evaluate the amount and nature of various types of information in activated memory records (e.g., criteria to evaluate the degree of match between the qualitative characteristics of a memory record and the known properties of particular sources). Heuristic old–new recognition judgments can use similar criteria and can use much less differentiated input to evaluate familiarity derived from such information as degree of activation of individual representations (Mandler, 1991), fluency (Jacoby & Dallas, 1981), amount of associative spread of activation (Gillund & Shiffrin, 1984), or "echo" intensity (Hintzman, 1988).[4] Speed–accuracy trade-off is one promising technique for mapping these attributional processes in more detail.

The class of heuristic processes used in memory decisions can, of course, serve functions other than recognition and source-monitoring judgments; they assess preferences, persuasiveness, similarity, and so forth. Clearly, heuristic decision making is quite flexible in the type of information that is taken as input and in the type of evaluations, attributions, and so on

[3] The concept of differentiation can be distinguished from that of specificity. Specificity is illustrated by the fact that priming is usually better when modality of input stays the same than when it changes (Kirsner & Smith, 1974). Differentiation is a psychological concept to express variations in phenomenal experience.

[4] Dual-process models of old–new recognition (Atkinson & Juola, 1973; Jacoby & Dallas, 1981; Mandler, 1980, 1991; see also Gardiner, 1989) include both a heuristic and systematic component. However, they typically treat only undifferentiated information (i.e., familiarity) as a potential input to heuristic recognition judgments. The second process, retrieval or recollection, tends to be treated as a search or retrieval with an all-or-none outcome. Both the heuristic and systematic components of dual-process theories would need to be elaborated along the lines that we describe to account for source monitoring, as well as to better describe old–new recognition decisions. The present discussion suggests ways in which the notions of familiarity and retrieval can be incorporated into a more embellished and general framework for memory attributions.

that is produced as output. In addition, the same information may sometimes be used for different purposes. For example, as Jacoby has also argued (e.g., Jacoby & Dallas, 1981), subjects might use perceptual fluency not only as an index of familiarity, but as an index for such diverse judgments as preference (Kunst-Wilson & Zajonc, 1980; Seamon, Brody, & Kauff, 1983), darkness or lightness of stimuli (Mandler, Nakamura, & Van Zandt, 1987), or ease of problem solution (Jacoby & Kelley, 1990; Kelley & Jacoby, 1993).

Similarly, both recognition and source monitoring can draw on more systematic processes, such as retrieving additional information, discovering relations, initiating new search strategies, and so forth. Important questions include whether the probability of using particular systematic processes (e.g., plausibility checks) differs for old–new recognition and source monitoring and how the criteria applied might differ. Like heuristic processes, systematic processes are recruited for a wide range of activities in addition to recognition and source monitoring, such as memorizing text (Intons-Peterson & Smyth, 1987) and evaluating persuasiveness of communications (Chaiken et al., 1989). Like heuristic cognition, systematic cognition is quite flexible in the information used as input and the types of evaluations, attributions, and so forth that are produced as output. The source-monitoring framework focuses on how these heuristic and systematic cognitive processes operate in source monitoring. (For further discussion about how a flexible cognitive system with a limited set of components might be configured to perform a wide range of tasks, see the last section, Source Monitoring Within a General Memory Architecture, and Johnson, 1991b; Johnson & Hirst, in press; Johnson & Multhaup, 1992.)

Source Monitoring and Indirect Tests of Memory

Dissociations between direct and indirect tests. Recently, considerable research effort has focused on dissociations between direct (recall and recognition) and indirect (especially priming) tests of memory (e.g., Richardson-Klavehn & Bjork, 1988; Roediger, Weldon, & Challis, 1989; Schacter, 1987a). Priming occurs when a prior exposure to an item facilitates subsequent performance on that item in tasks that are not presented to subjects as memory tests—for example, when prior exposure increases the probability that a word will be identified under degraded stimulus conditions; the speed with which a word can be responded to in a lexical decision task; or the likelihood that it will be given as a response in free association, word stem completion, or homophone spelling. Amnesic patients who are impaired in recall and recognition show intact priming in a variety of tasks (Schacter, 1987a; Shimamura, 1986, 1989; Tulving & Schacter, 1990; Warrington & Weiskrantz, 1968, 1970). In normal subjects, priming may occur even when recognition is at chance levels (Eich, 1984). Certain experimental manipulations that improve recall and recognition (e.g., elaborative processing) are less likely to affect priming (Graf & Mandler, 1984; Hashtroudi, Ferguson, Rappold, & Chrosniak, 1988; Jacoby & Dallas, 1981; but see Rappold & Hashtroudi, 1991; Toth & Hunt, 1990). Changes in modality of presentation decrease performance on priming tests but have less effect on recall and recognition (Graf, Shimamura, & Squire, 1985; Jacoby, 1983; Roediger & Blaxton, 1987a, 1987b).

According to the source-monitoring framework, one reason that dissociations between direct and indirect tests arise is because priming typically reflects facilitated processing (e.g., facilitated perceptual processing) of an undifferentiated sort (see Figure 1B) and need not engage the source-monitoring processes that we have described, whereas direct memory tests always involve processes that result in some specification of source. Amnesic subjects are not impaired in priming because the primary memory deficit in these subjects is in reflective processes that are not required in priming but that establish differentiated information critical for source monitoring (Johnson, 1990; Johnson & Hirst, 1991; see also the Disruption of Source Monitoring section). Elaborative manipulations do not affect priming because elaborative processing contextualizes information and because differentiated contextual information is not necessary in most priming tasks. Changes in modality reduce priming because they reduce the chances that test probes will activate previous records (Bransford, Franks, Morris, & Stein, 1979; Kolers & Roediger, 1984).

Indirect tests of source information. Elsewhere in this review, we are primarily concerned with memory for source as a phenomenal experience (i.e., the subjective experience of remembering source). However, evidence of source-specific information in memory records can be obtained without subjects phenomenally experiencing the source. Greater priming or recognition (Craik & Kirsner, 1974; Kirsner, 1974) when presentation modality is constant between study and test provide indirect indexes of source information (see also Kelley et al., 1989). The advantage of source constancy may occur even when subjects have difficulty in directly specifying the source (cf. Jacoby & Brooks, 1984).

This dissociation between direct and indirect tests of source information can be described in terms of the framework used here for understanding source monitoring. Enhanced recognition memory when modality is constant between study and test can be mediated by relatively undifferentiated information (e.g., fluency in perceptual processing) that contributes input to a heuristic-recognition judgment process. Direct decisions regarding source, however, usually involve an attribution that is based on more differentiated information as input to heuristic and, perhaps, more systematic processes.

Direct and indirect tests of memory will not always be dissociated as both types of tests may be based on the same information (see Figure 1B). For example, Kelley, Jacoby, and Hollingshead's (1989) subjects read some words and heard others. In a subsequent combined visual–perceptual identification and modality-judgment task, compared with items not perceptually identified, identified items were more likely to be called "read" than "heard" regardless of whether the item had actually been read, heard, or was new. Kelley et al. suggested that fluent perceptual processing is experienced by subjects as familiarity and that more familiar items will seem to have been presented in the same modality at test as at study. In a second experiment, during the study phase, some subjects thought about positive aspects of read items and negative aspects of heard items (or vice versa). In the subsequent perceptual identification and modality-judgment tasks, the bias to respond "read" to perceptually identified words was markedly reduced. Evidently, subjects in the elaboration group relied less on perceptual fluency for making modality judgments because they had an alternative basis for judgment: the different semantic information associated with read and heard items. Thus, like source monitoring and recognition, direct and indirect tests may or may not be dissociated, depending on the type of information that is used in the two tests.

Eyewitness Testimony

The fact that subjects are susceptible to misleading suggestions regarding recently witnessed events is of considerable practical and theoretical interest (e.g., Loftus, 1979a; D. F. Ross, Read, & Toglia, in press; Wells & Loftus, 1984). The standard suggestibility procedure involves presenting visual information followed by verbal misinformation and then later testing subjects' memory of the visual information. Subjects often claim to have seen things that were presented only in the verbal suggestions. Recent debate has focused on whether misleading suggestions impair subjects' memorial records of the visual information (e.g., Belli, Windschitl, McCarthy, & Winfrey, 1992; Ceci, Ross, & Toglia, 1987; Chandler, 1991; Lindsay, 1990; Loftus, Donders, Hoffman, & Schooler, 1989; McCloskey & Zaragoza, 1985; Tversky & Tuchin, 1989). Although the memory impairment question is important, the question of whether misled subjects remember seeing suggested details in the event is equally important (Lindsay, in press; Lindsay & Johnson, 1989; Zaragoza & Moore, 1990). The source-monitoring framework suggests guidelines for predicting the likelihood of such source confusions.

According to the source-monitoring hypothesis, memory errors may occur at test when misled subjects erroneously identify memories derived from the misleading information as memories derived from the witnessed event itself. Subjects' source judgments should be affected by the decision-making processes and criteria they adopt on the test (Hasher & Griffin, 1978; Johnson, 1988a; Raye et al., 1980). The criteria that subjects use to attribute a memory to a particular source will vary with factors such as the purpose of the remembering, the biases that are active, and the weight given to plausibility (Johnson, 1988a). Under some conditions, it might be sufficient that an item is vaguely familiar and fits with other details derived from that source; under other circumstances, other information, such as a perceptually detailed recollection, might be required.

The recognition tests that are typically used in studies of eyewitness suggestibility may tacitly induce subjects to make source-monitoring errors on the critical items. In the standard procedure, subjects receive a series of recognition trials consisting of items from the original event and new distractor items (in the form of either forced-choice pairs or individual yes–no items). The critical test items, in which the suggested objects appear, are embedded among these filler items. Because most of the test items require subjects to discriminate between objects presented in the visual event and completely new distractors, subjects may adopt an undifferentiated familiarity criterion (Atkinson & Juola, 1973; Jacoby & Dallas, 1981; Mandler, 1980) early on in the test and stop attending to potentially useful information about the sources of their memories (e.g., the amount and nature of perceptual detail). When a suggested item is encountered on the test, subjects may recognize it as something that was presented during the experimental session and, because they are using a familiarity criterion, indicate that they remember seeing that item in the original event. On a forced-choice test, the suggested item in a test pair may seem more familiar than the original item for a number of reasons (e.g., recency or salience). Thus, standard testing procedures with both yes–no and forced-choice recognition tests may lead subjects to base judgments on familiarity and, hence, to ignore memory information about the source of an item's familiarity (cf. Raye, 1976). Subjects should thus make fewer errors if they are oriented toward source-monitoring judgments (e.g., Raye & Johnson, 1980) rather than familiarity judgments (e.g., Loftus, 1979a).

Lindsay and Johnson (1989) and Zaragoza and Koshmider (1989) recently found evidence that was in keeping with this prediction. In the Lindsay and Johnson studies, subjects first viewed pictorial target information and then received verbal postevent information with or without misleading suggestions. Later, half of the subjects received a yes–no recognition test that required them to indicate which items they had seen in the picture and which they had not. The other half received a source-monitoring test that required them to indicate the source (picture, verbal narrative, or both) of their memory of each item that they recognized as old. As is typically found, when tested with the recognition procedure, misled subjects often claimed that they had seen things that had only been suggested in the text. In contrast, there was no suggestibility effect among subjects tested with the source-monitoring test: These subjects correctly attributed suggested details to the narrative. Zaragoza and Koshmider (1989) found similar results with a slightly different source-monitoring test. These results are consistent with the idea that source attributions are the result of decision processes that are subject to criteria effects.

Subsequent experiments have demonstrated that even subjects given a source-monitoring test sometimes claim to have seen suggested details (e.g., Lindsay, 1990; Zaragoza & Muench, 1989). In the Lindsay (1990) study, subjects in the easy source-monitoring condition received misleading suggestions 2 days after viewing the event, minutes before taking the test, and under conditions that differed from those in which they viewed the event. Subjects in the difficult condition, on the other hand, received the misleading suggestions minutes after viewing the event, under very similar conditions, 2 days before taking the test. Before taking a recall test, subjects were correctly informed that anything mentioned in the postevent narrative that was relevant to any test question was wrong. That is, subjects were explicitly told not to report anything that they remembered from the postevent narrative (an adaptation of Jacoby's "logic of opposition," e.g., Jacoby, Woloshyn, & Kelley, 1989). Subjects in the easy condition showed no tendency to report suggested details, indicating that subjects understood and attempted to follow the injunction against reporting information from the postevent narrative. Nonetheless, subjects in the difficult condition quite often reported seeing the suggested details. Taken together, two points are clear from these studies: (a) The likelihood of source misattributions depends on the criteria subjects adopt in making source-monitoring judgments (see also Dodson & Johnson, in press; Hasher & Griffin, 1978; Raye et al., 1980), and (b) source misattributions may occur even under quite stringent criteria.

In addition to helping to characterize criteria effects in eyewitness testimony, the source-monitoring framework suggests other factors that will influence such memory errors. For example, source misattributions should be more likely when subjects incidentally visualize misleading information (e.g., Durso & Johnson, 1980; Finke et al., 1988; Intraub & Hoffman, 1992; Zaragoza, 1991) or imagine suggested utterances in one of the actor's voices (e.g., Johnson, Foley, & Leach, 1988). Subjects should also be more likely to make source confusions when they consider misleading information tangential and do not contextualize it as part of an event distinct from the original event. This may be one reason that it is easier to induce subjects to make errors on peripheral than on central details (Loftus, 1979b; Tousignant, Hall, & Loftus, 1986). Source misattributions should also be more likely when subjects are stressed or distracted at the time that the misinformation is introduced (or tested) because, again, they would be less likely to engage in processes that would produce potential source cues for the misinformation (Zaragoza & Lane, 1991). In keeping with evidence that source-monitoring processes develop and change with age (see sections in this article on development, p. 7, and aging, p. 16), there are age-related changes in children's (Ceci & Bruck, 1993) and elderly adults' (Cohen & Faulkner, 1989) susceptibility to misleading suggestions.

Misattributing Familiarity

Failures in source monitoring may give rise to the feeling that a name or a fact that is familiar from a recent exposure was known previously (e.g., Begg, Robertson, Gruppuso, Anas, & Needham, 1992; Jacoby, Kelley, Brown, & Jasechko, 1989; Kelley & Lindsay, 1993; Neely & Payne, 1983; Schacter et al., 1984). For example, Jacoby and colleagues reported a number of interesting experiments all involving two phases. In Phase I, subjects read a list of nonfamous names (e.g., Sebastian Weisdorf), and in Phase II, subjects made fame judgments for a list containing both Phase I nonfamous names, new nonfamous names, and famous names. Before they made their fame judgments, subjects were told that all Phase I names were nonfamous. On an immediate test, subjects were less likely to call Phase I nonfamous names famous than to call new nonfamous names famous. When Phase II was delayed, however, subjects were more likely to call Phase I nonfamous names famous than to call new nonfamous names famous, suggesting that subjects based fame judgments on overall familiarity of the name and had forgotten, or were not accessing or using, source information. Thus, they misjudged the basis for the familiarity of Phase I items as preexperimental. These findings illustrate that people sometimes recognize information but not its source (e.g., Johnson & Foley, 1984; Johnson & Raye, 1981; Lindsay & Johnson, 1987) and that recognition and identification of origin may be based on different aspects of memory or different relative contributions of heuristic and systematic processes (e.g., Foley et al., 1983; Johnson, 1985; Johnson & Raye, 1981; Lindsay & Johnson, 1991; Raye & Johnson, 1980).

The criteria subjects use will affect the extent to which they confuse information from two sources (e.g., Lindsay & Johnson, 1989; Raye et al., 1980; also see Hasher & Griffin, 1978). In keeping with this, Jacoby, Kelley, Brown, and Jasechko (1989) found that discrimination between famous and nonfamous names was better when the test list included names that had been presented earlier than when it did not. Thus, when subjects realized that they might be confused about the source of a familiarity response, they would tighten their criteria for calling a name famous. For example, they might not say someone was famous unless they could remember what he or she did.

Limiting reflective activity at either encoding or source judgments will also produce impoverished memories or judgment processes that may lead to errors in source monitoring (Jacoby, 1991). Jacoby, Woloshyn, and Kelley (1989) varied whether subjects simply read names in the first phase (full-attention condition) or at the same time listened for runs of three odd numbers in a tape-recorded series of random digits (divided-attention condition). Divided attention reduced old–new recognition but not the increment of error in fame judgments caused by recent exposure. This was true even when subjects were informed that all names on the initial list were nonfamous and that if they remembered a name from the initial list, they should say that it was nonfamous. Thus, when study was under conditions of divided attention, subjects were unable to "correct" the sense of familiarity (that might be misattributed to fame) with further information, presumably because under divided-attention conditions, they were less likely to engage in the additional processing necessary to establish information that could later be used to identify the source of the familiarity response.

In interpreting these results, Jacoby and colleagues suggested that such misattributions of familiarity to past knowledge were an example of a more general class of misattributions, which was based on "fluency" of processing (Jacoby, Kelley, & Dywan, 1989; Jacoby, Woloshyn, & Kelley, 1989; Kelley & Jacoby, 1990). For example, briefly flashing a word immediately before its presentation as a recognition probe increases the likelihood that subjects will identify that word as a word from the study list; presumably the flashed preview of the word facilitates processing of the recognition probe, and that fluent processing is taken as evidence of having previously encountered the word on the list (Jacoby & Whitehouse, 1989). Likewise, prior exposure to solution words facilitates solving anagrams, which in turn leads subjects to underestimate the difficulty of those anagrams for others (Kelley & Jacoby, 1993).

Jacoby's ideas and those presented here are not contradictory, but they do differ substantially in emphasis. Like the view expounded here, Jacoby and colleagues (e.g., Jacoby & Dallas, 1981; Jacoby, Kelley & Dywan, 1989) hold that the subjective experience of remembering is not the result of some intrinsic quality of "memory traces," but rather reflects the operation of a decision process that attributes current mental events to particular sources (e.g., memory). Jacoby's work has focused primarily on attributions that are based on fluency. The feeling of familiarity is said to arise from an undifferentiated (see discussion of Figure 1) or global assessment of processing ease or fluency; specific qualitative characteristics of memories do not enter into fluency judgments. Our work on source monitoring, on the other hand, has focused on attributions that are based on qualities of memories such as perceptual detail, cognitive operations, contextual information, and affect.

Jacoby contrasts judgments that are based on familiarity, an automatic process, with judgments that are based on controlled recollection. Jacoby's idea that recollection can counteract the results of a fluency-based familiarity judgment is similar to our idea that more systematic processing can counteract judgments that might otherwise be based on heuristic processing (e.g., Johnson, 1991a; Johnson & Raye, 1981). However, in Jacoby's work, recollection of prior episodes has often been treated as something that either occurs or does not occur. Research on source monitoring, in contrast, has emphasized the idea that recollection occurs in degrees and produces variations in the phenomenal qualities of memories. Finally, the term *recollection,* in Jacoby's work, usually refers to direct retrieval of records of past episodes. Source monitoring processes include not only retrieval but also interpretation of what is retrieved. Work on source monitoring addresses the question of what gives rise to the feeling that a specific past episode has been retrieved. The source-monitoring framework attempts to characterize the various dimensions of phenomenal experience that are relevant for attributing memories to particular sources, the way conditions affect which aspects of memory will be criterial, and the way such information interacts with decision (attribution) processes.

Cryptomnesia

Cryptomnesia is inadvertent plagiarism that occurs when a person produces something and believes that it is an original, self-generated product of the moment when, in fact, it was perceived (or generated) earlier. A. S. Brown and Murphy (1989) obtained cryptomnesia experimentally. Small groups of subjects took turns generating exemplars of categories. Later, subjects tried to recall the items they had themselves generated and to produce new items not given before by anyone. Cryptomnesia was obtained from most subjects in that during the initial generation phase they gave items given earlier by others and also in that they later claimed to have generated exemplars that had been produced by others in the group. Furthermore, subjects were more likely to plagiarize from subjects who came before them in the generation order than from subjects who came after them. A. S. Brown and Murphy suggested that subjects were especially likely to be thinking of their next response just before it was time for them to give it and probably processed the events just preceding their turn less completely than the events after their turn (Brenner, 1973). Thus, subjects might have failed to establish memories with the kind of perceptual, contextual, and reflectively generated detail on which correct source attributions depend. The source-monitoring framework also suggests that subjects may have in fact covertly generated an item that was subsequently given by another subject before they had a chance to report it. The discrimination (thought and heard vs. thought and said) would be even harder in such cases.

Considered together with the Jacoby, Kelley, Brown, and Jasechko (1989) and Jacoby, Woloshyn, and Kelley (1989) "false-fame" studies, the results reported by A. S. Brown and Murphy (1989) suggest that phenomenal differences between material that has been recently experienced and material that has not been recently experienced (e.g., differences in perceptual fluency, differences in familiarity, and differences in availability) can become the bases for particular decisions, depending on task demands (see also Hasher, Goldstein, & Toppino, 1977; Mandler et al., 1987), especially when other kinds of source information are not readily available. If the task is to recognize famous names, the familiarity that comes from recent activation can be interpreted heuristically as familiarity from preexperimental experience. If the task is to generate new items (A. S. Brown & Murphy, 1989; Kubovy, 1977), to solve problems (Kelley & Jacoby, 1993), or to answer questions (Begg & Armour, 1991; Kelley & Lindsay, 1993), the availability that comes from recent activation may be interpreted as (unaided) generation of the moment. Subjects are "fooled" in both cases because the discrimination is difficult; the familiarity from recent activation of a new name may be indistinguishable from the familiarity from preexperimental experience of the sort that creates a vaguely familiar name. The false-fame effect should thus be much reduced if the familiarity of the famous names on the test list is increased, because this should increase the criterion subjects use for judging a name famous from prior experience.

Similarly, it is hard to distinguish the cognitive operations that go into generating from those that go into inadvertent plagiarizing in the category-exemplar-generation task. In both cases, subjects presumably retrieve exemplars activated by the category name that have little other operations information to distinguish them. Johnson et al. (1981; see also Rabinowitz, 1989) found that compared with high-frequency instances, subjects were better able to identify whether they had generated or the experimenter had presented low-frequency instances of categories, presumably because lower frequency instances took more cognitive operations to generate, which could then be used as cues to the origin of the information. From the Johnson et al. (1981) finding, we would expect that subjects in the A. S. Brown and Murphy (1989) procedure would make fewer cryptomnesia errors if instructed to generate low-frequency category instances. Although A. S. Brown and Murphy did not specifically manipulate instance frequency in their experiment, in keeping with what we would expect, they reported that errors were more likely on the higher frequency exemplars given by subjects in their experiment.

Incorporating Fiction as Fact

Another clearly important source-monitoring problem concerns the extent to which the fictional accounts that we read or hear are incorporated, along with accurate accounts and our own direct experiences, into our general knowledge and beliefs. Movies, television, books, magazines, newspapers—all are sources of fictional information that may, under some circumstances, be treated as reliable information. A particularly striking example of this phenomenon was illustrated in a "60 Minutes" program broadcast on CBS television that showed then-president Ronald Reagan recounting a story to Navy personnel about an act of heroism that he attributed to a real U.S. pilot but that bore an uncanny resemblance to a scene from a Dana Andrews movie released in the 1940s. According to the report of this incident, no record of a similar, real act of heroism could be found.

As with other source-monitoring situations, we would expect confusion between fact and fiction to be related to factors that affect the quality of source-specifying information encoded at acquisition and to factors that affect source-monitoring processes later. Some evidence in support of this general idea comes from reports of attempts to study the incorporation of fictional accounts into general knowledge (J. R. Anderson & Ross, 1980; Gerrig & Prentice, 1990, 1991; Potts & Peterson, 1985; Potts, St. John, & Kirson, 1989). For example, subjects in the Potts et al. experiment read passages including information about a bird called a "takehe" and its ancestor the "pukeko." Subjects were told either that the information to be studied was real or that it was fictional. Later, subjects responded "true" or "false" to statements such as "The pukeko is a bird" or "The pukeko has feathers." If most of the verification questions concerned story concepts, response times were faster for subjects who were told that the material was artificial. If most of the questions did not concern the story, response times were faster for subjects who were told that the material was real. Potts et al. suggested that subjects who were told that the material was real had fast response times in the nonstory context because they had integrated the material into general knowledge in such a way that it would, like semantic knowledge in general, be less dependent on any particular context for its retrieval.

Potts et al. (1989) further suggested that subjects had some degree of strategic control over whether information would be incorporated into their knowledge base or compartmentalized. We interpret *compartmentalized* to mean that source-specifying information is available. The strategic activities that Potts et al. had in mind presumably were the sorts of reflective activities that establish complex memory records of the sort that form the basis for source monitoring (e.g., Johnson, 1983, 1992). For example, if subjects process information reflectively (e.g., retrieve additional information and note potential differences between fictional birds and real birds when presented with fictional information), the records of this reflection may be available for source-monitoring decisions later.

In another study of confusion between fact and fiction, Gerrig and Prentice (1990) had subjects read a story and rate how interesting it was. After a brief filler task, subjects indicated their opinions about a number of topics, including some that had been discussed in the story. Subjects' opinions were affected by false facts introduced in the stories (e.g., that chocolate might be carcinogenic). Particularly interesting was the finding that subjects who rated a story as less interesting were more likely to have their opinions affected by it. Gerrig and Prentice suggested that compartmentalization required special effort that was correlated with interest. In the source-monitoring framework, the special effort would be the sorts of reflective activities that would embed the information in related information that could later help identify its source when subjects were making their opinion ratings and that would allow them to discount the information. Subjects who are not interested in a story should be less likely to engage in such activity and, paradoxically, later might be more influenced by information from the story than are more interested and therefore more reflective subjects. As in the "sleeper effect" (Pratkanis, Greenwald, Leippe, & Baumgardner, 1988), long retention intervals might also be expected to increase the influence of fictional information.

Disruption of Source Monitoring

Source monitoring is an integral part of normal cognition, but source-monitoring processes are imperfect, so errors are inevitable. Although many of these errors are of no great consequence, some have important practical, social, and emotional consequences (e.g., errors in courtroom testimony and failure to credit another's ideas). Under some circumstances, people suffer even more profound disruptions in source monitoring—as in hypnosis, hallucinations, delusions, confabulation, and amnesia and as a consequence of aging. The breakdowns that occur in source monitoring under such conditions of disrupted cognition provide potentially valuable information about the nature of source-monitoring processes (and, indeed, monitoring processes in general), as well as an opportunity to evaluate the usefulness of the source-monitoring framework in understanding disrupted cognition.

Delusions, Hallucinations, and Confabulations

As we argue here and elsewhere (e.g., Johnson, 1988a; Johnson & Raye, 1981), reality is not given directly in perceptual and memory representations but is a product of judgment processes. The characteristics of mental experience that provide it with the quality of reality are similar for perceptions, event memories, and beliefs: sensory detail; embeddedness in spatial and temporal context; embeddedness in supporting memories, knowledge, and beliefs; affect; and the relative absence of consciousness of the cognitive operations producing the event or belief. Reality testing of ongoing perception and reality monitoring of memories and beliefs are complex judgment processes that are subject to error and are more difficult in some situations than in others. The importance of qualitative characteristics of memories and of intact judgment processes is especially clear in considering such phenomena as delusions (see chapters in Oltmanns & Maher, 1988), hallucinations (Hilgard, 1977; Horowitz, 1978), and confabulations (Baddeley & Wilson, 1986; Johnson, 1991a; Moscovitch, 1989; Stuss et al., 1978).

Clinically significant false or implausible personal beliefs that are firmly held in spite of evidence to the contrary are classified as *delusions* (Oltmanns & Maher, 1988). Many of the factors that we have postulated to be important in reality monitoring under ordinary circumstances are implicated in the development and maintenance of delusions (Johnson, 1988a). Delusions are likely to involve imagined sensory information (e.g., another person's voice) that even nondelusional people sometimes find difficult to distinguish from real perceptual events (Johnson, Foley, & Leach, 1988). Delusions involve a loss of control over thoughts and typically involve thoughts that come automatically, or unbidden. Such thoughts produce little reflective, cognitive-operations information and so are particularly easy to confuse with external stimuli (e.g., Durso & Johnson, 1980; Finke et al., 1988; Johnson, 1991b). Furthermore, a delusional person may find elaborate connections among many separate events. Because the retrieval of supporting memories is taken as evidence that an event occurred (Johnson, Foley, Suengas, & Raye, 1988), this may lead to incorrectly identifying imagined events as perceived. Finally, cognitive habits or the intermixture of cognitive and motivational effects (e.g., Johnson & Sherman, 1990) may induce delusional people to use inappropriately lax criteria for evaluating mental experiences. As described earlier, even normal people, when induced to use lax criteria, make misattributions about the source of information that they would not make if they were using more stringent criteria (e.g., Lindsay & Johnson, 1989; Raye et al., 1980).

Similar points can be made about the reality-testing errors that produce hallucinations (Perky, 1910; Segal, 1970). That is, hallucinations can be analyzed according to many of the same factors that have been shown to influence reality monitoring in normal individuals (e.g., Bentall, 1990; Horowitz, 1978; Johnson, 1988a). Kunzendorf (1985–1986) specifically suggested that certain hallucination phenomena occurring in hypnosis result from the suspension of a reality "monitor" (p. 258). An important difference between Kunzendorf's notion of a reality monitor and our notion of reality-monitoring processes is that Kunzendorf's monitor is a relatively simple device for reading an unambiguous "tag" (p. 257) that specifies that a given sensation is an image or a percept. In contrast, we assume that various qualitative characteristics of activated information are evaluated and that the decision processes are more complex than simply "reading out" a single index of source information.

Patients who have suffered organic brain damage sometimes make false statements, apparently without intending to deceive, which are classified as *confabulations* (Talland, 1961; Whitlock, 1981). Published descriptions of confabulating patients are particularly interesting because they are generally consistent with the idea that reality monitoring involves at least two kinds of judgment processes: one that is based on a nondeliberative evaluation of the characteristics of activated information, such as the type and amount of perceptual detail, and the other that is based on a more deliberate evaluation of the meaningful content of activated information in the light of other memories and knowledge (Johnson, 1991a).

Patients who have had a cingulectomy (to treat obsessive–compulsive behavior) sometimes experience reality-monitoring failures that appear to be the consequence of unusually vivid mental experiences. They will report something as real, but they may catch themselves (e.g., in answer to a question, one patient said "I have been having tea with my wife" but then said, "Oh, I haven't really. She's not been here today. . . . The scene occurs so vividly, I can see the cups and saucers and hear her pouring out" (Whitty & Lewin, 1957, p. 73). It is as if vivid imaginations initially pass a heuristic reality-monitoring check on the basis of qualitative characteristics and are accepted as real until caught by more systematic processes. In contrast, patients with frontal damage who confabulate may experience reality-monitoring failures that appear to be the consequence of errors resulting from disruption in more extended reasoning processes. These patients sometimes make bizarre or implausible statements. For example, one frontal patient claimed that he was shot and killed by a young woman during World War II but that the surgeons brought him back to life (Stuss et al., 1978). More systematic processes are responsible for catching implausible ideas that may pass a more heuristic reality-monitoring check.

Amnesia

There is considerable evidence that failure to remember source may be an important component of amnesia (J. Brown & Brown, 1990; Graf, Squire, & Mandler, 1984; Hirst, 1982; Hirst & Volpe, 1982, 1984; Huppert & Piercy, 1976; Johnson & Hirst, in press; Mayes et al., 1985; Meudell, Mayes, Ostergaard, & Pickering, 1985; Pickering, Mayes, & Fairbairn, 1989; Schacter et al., 1984; Schacter & Tulving, 1982; Shimamura & Squire, 1987, Smith & Milner, 1989; Weinstein, 1987, cited in Johnson, 1990). Various studies have shown disruptions in amnesics for memory for temporal (Squire, 1982) and spatial (Mayes, Meudell, & MacDonald, 1991; Shoqeirat & Mayes, 1991) information and modality of presentation (Pickering et al., 1989). Schacter et al. (1984) investigated source monitoring in amnesics by means of a memory-for-trivia-facts paradigm. They presented amnesic patients with statements that included fictional information about well-known people (e.g., "Bob Hope's father was a fireman"). After brief intervals, amnesic patients could sometimes produce the studied information when cued with questions but often could not remember whether they learned those facts in the experiment or from an extraexperimental source (e.g., television or newspapers). Schacter et al. (1984) referred to this finding as "source amnesia," which they defined as "retrieval of experimentally presented information in the absence of a corresponding recollection of how it was acquired" (p. 593).

Schacter et al. (1984) distinguished between *source amnesia* and *source forgetting.* Source amnesia occurs when subjects do not remember whether an item was learned in the experiment or outside the experiment. Source forgetting occurs when subjects can remember that an item was learned in the experiment but do not remember the specific source (e.g., which of two speakers said it). From the present perspective, *source* is a shorthand way of referring to a variety of types of information (e.g., spatial, temporal, and voice) that may be accessible to different degrees or with varying probability and thus may yield source identifications of varying degrees of specificity. The issues here are analogous to those concerning the relation between old–new recognition and source monitoring. From the source-monitoring point of view, source forgetting and source amnesia are both examples of source-monitoring failures that simply reflect differences in either the amount or the specificity of information available about various external sources. In any case, the fact that some amnesic subjects have so little source information available after so short a retention interval is a striking phenomenon.

These findings suggest that those aspects of memory that would ordinarily support source monitoring are profoundly impaired in amnesia. Thus, severely amnesic subjects may have access to relatively little differentiated information about qualitative characteristics of memories such as perceptual detail (e.g., the voice in which something was said). They also may have little access to records of prior reflective activity such as noting relations among events. Without such source-relevant information, they may base their source-monitoring judgments in the context of trivia questions on combinations of cues and criteria that lead to many errors (e.g., "Why would 'fireman' come to mind when I think about Bob Hope's father unless I had read or heard about it someplace before; it must be true but I don't remember the specifics of learning it, and I'm not very good at learning new things, so I probably learned it a long time ago"; cf. Begg & Armour, 1991; Kelley & Lindsay, 1993).

Some further clues about the nature of amnesic source monitoring might be obtained by comparing amnesic patients' performance in various source-monitoring situations. That is, amnesics may not be disrupted equally in all source-monitoring situations. To investigate this possibility, Johnson, Hirst, Phelps, Multhaup, and Volpe (1992) tested 5 mixed-etiology, nonalcoholic amnesics (and 5 control subjects) in two tasks that required subjects to identify who said what. In one, subjects watched a video in which an experimenter asked questions (e.g., "Name a type of coin that used to be larger than a quarter") and 2 people alternated giving the answers (e.g., a penny). Subjects later were read the words given as answers and had to indicate who said each item (external source monitoring). In the other task, 1 person gave some of the answers (again on video), and the subject was required to give the others (cued by first letters). Here, too, subjects were asked who said each word (an internal–external discrimination, or reality monitoring). Amnesics showed source-monitoring deficits for both external source monitoring and reality monitoring, but the deficit in external source monitoring appeared to be greater than the deficit in reality monitoring. Even so, in the reality-monitoring task, amnesics were particularly poor at identifying the source of items they had generated (also the case in a follow-up experiment). These results, although preliminary, suggest that amnesics may be disproportionately disadvantaged in remembering what they have generated compared with what they have perceived. Assuming that source identification of self-generated items draws on records of cognitive operations more than does identification of perceived items, these findings are consistent with the suggestion that amnesics are more disrupted in self-generated, reflective memory than in perceptual memory processes (Hirst et al., 1986; Hirst, Johnson, Phelps & Volpe, 1988; Johnson, 1983, 1990; Johnson & Hirst, 1991).

More generally, systematic comparisons of which aspects of source (e.g., temporal, spatial, modality of presentation, and person's voice) are particularly difficult for various memory-disordered subjects would be especially useful in clarifying the role of source memory in memory disorders (cf. Smith & Milner, 1984). As is discussed in the Brain Regions Implicated in Source Monitoring section, various aspects of source may be differentially disrupted by damage to various regions of the brain.

Aging

One line of evidence for age deficits in remembering source comes from studies demonstrating that older adults have difficulty in remembering contextual information (Burke & Light, 1981). Older adults have trouble in remembering spatial location (e.g., Light & Zelinski, 1983; Park, Puglisi, & Lutz, 1982; Perlmutter, Metzger, Nezworski, & Miller, 1981), sex of voice (Kausler & Puckett, 1981), upper versus lower case format (Kausler & Puckett, 1980), and list membership (Zelinski & Light, 1979 [cited in Burke & Light, 1981]) of presented information. Burke and Light suggested that the inability to use contextual information may be a key mechanism involved in age deficits in memory. This idea is consistent with the finding that age differences tend to be greatest when testing procedures provide the least amount of contextual support for retrieval, as in free recall, in which subjects must reconstruct the original events (Craik, 1984; Hultsch & Dixon, 1990; Light & Singh, 1987).

Another line of evidence comes from more recent studies in the source-monitoring tradition. McIntyre and Craik (1987), using a procedure similar to Schacter et al.'s (1984), found that after a week, older adults remembered trivia facts as well as young adults but had difficulty determining whether a particular fact was learned in the experiment or outside the experiment. Older adults also had trouble remembering presentation modality (experimenter vs. an overhead projector). Similarly, Dywan and Jacoby (1990), using the fame judgment task described earlier (Jacoby, Kelley, Brown, & Jasechko, 1989), found that older subjects were more likely than young subjects to mistakenly call the nonfamous names from an earlier presentation phase famous.

Rabinowitz (1989) reported that older subjects had more difficulty discriminating between previously read and previously generated (e.g., A_CO_OL) words than did young subjects. In a conceptually similar study (subjects read some entire sentences and filled in the last word for others), Mitchell, Hunt, and Schmitt (1986) did not find age differences in remembering the source of information but noted that a ceiling effect may have masked a source-monitoring deficit among the older subjects.

In a study by Cohen and Faulkner (1989), older and younger subjects watched, performed, or imagined themselves performing a series of simple actions (e.g., "Put the spoon next to the toothbrush"). At test, older subjects were more likely than young subjects to say that imagined actions had been watched and that watched actions had been performed. Cohen and Faulkner also showed that older subjects were more often misled by false information than were younger subjects in an eyewitness-testimony paradigm (Loftus, 1979a). In a study by Kausler, Lichty, and Freund (1985), however, older adults did not have difficulty discriminating between memories for activities (e.g., card sorting) that were planned and those that had been performed. Similarly, in another study (Guttentag & Hunt, 1988), only a minority of older subjects had difficulty discriminating between performed and imagined actions.

These studies suggest that there are age differences in source monitoring, but taken together, they also suggest that these differences depend on the type of source-monitoring task a person confronts. Direct evidence for this point was reported by Hashtroudi et al. (1989). Older and younger adults were presented with a list of common words originating from different sources. Compared with young adults, older adults had difficulty discriminating memories of words they had said from memories of words they had imagined saying (internal source monitoring) and difficulty discriminating which of two other people had said particular words (external source monitoring; see also Schacter et al., 1991). In contrast, they did not have more difficulty in discriminating words they had said from words someone else had said or words they imagined saying from words someone else had said (reality monitoring). (Reality-monitoring difficulties have been demonstrated in older subjects in other situations, e.g., Hashtroudi, Johnson, & Chrosniak, 1990; Rabinowitz, 1989.)

Hashtroudi et al. (1989) suggested that the particular pattern of source-monitoring deficits obtained provided a clue about which memory characteristics contributed to the age deficit in their experiment. On the basis of previous evidence (Johnson et al., 1981; Rabinowitz, 1989), it was assumed that with verbal material, the amount and kind of information about cognitive operations were especially salient cues for source monitoring. In the Hashtroudi et al. study, older adults did not have difficulty discriminating either what they said aloud or what they thought from what they heard another person say. In these conditions, the amount of cognitive operations presumably could be used as a cue that an item was generated rather than perceived. This suggests that older adults used these cues as well as young subjects. In contrast, the cognitive operations involved in saying and thinking are likely to be similar, thereby reducing the effectiveness of cognitive operations as a cue to source in discriminating what one said from what one only imagined saying. Presumably, subjects then have to rely either on memory for motoric and kinesthetic information or on memory for specific perceptual information about voice quality. In this situation, older adults seemed to have difficulty in discriminating source. Similarly, discriminating which of two other people said something should also depend on evaluating perceptual information such as specific voice quality, because the amount or kind of cognitive operations would not provide a reliable cue to source. Again, older adults had difficulty in this condition. Thus the results of this experiment provided a hint that older adults have the most trouble in conditions in which perceptual information is particularly important.

In a second study, Hashtroudi et al. (1990) directly examined age-related differences in various memory characteristics. The question addressed was whether some memory characteristics (e.g., perceptual and contextual) were affected more by aging than others. In this study, all subjects participated in some everyday situations (e.g., packing a picnic basket) and imagined themselves participating in other situations. On a second day, subjects recalled all they could remember about each situation. Recollections were evaluated for mention of information such as colors, objects, spatial references, and thoughts and feelings. Older adults had particular difficulty in remembering perceptual and contextual (spatial) information. In addition, in a reality-monitoring test given 3 weeks later, older adults had lower performance than young adults. Because perceptual information is likely to be a salient cue for reality monitoring, Hashtroudi et al. suggested that reality-monitoring difficulties might be related to older adults' difficulty remembering sensory–perceptual information.

Further evidence that older subjects have difficulty encoding perceptual cues is that an age deficit in identifying which of two female speakers had said particular words was eliminated when one speaker was a female and one a male (Ferguson et al., 1992; see also Lindsay et al., 1991). Ferguson et al. also found that increasing the salience of the spatial cues in the male–female condition by having the two speakers sit in distinctive spatial locations improved young adults' source-monitoring performance but not that of older subjects. We are currently exploring the hypothesis that older adults have difficulty encoding or using multiple cues to source.

These studies demonstrate how predictions generated by the source-monitoring framework can be used to explicate the mechanisms of source-monitoring deficits. Given that source monitoring is based on memory characteristics, one can systematically examine the contribution of various types of memory characteristics to source-monitoring deficits. This method of examining cue effectiveness of various memory characteristics provides a powerful tool for understanding source-monitoring processes.

Brain Regions Implicated in Source Monitoring

Frontal areas. A number of lines of evidence suggest that frontal-lobe dysfunction may produce deficits in source monitoring. Patients with frontal damage may recall or recognize information at normal levels yet show disrupted memory for temporal order (Milner, 1971; Milner, Petrides, & Smith, 1985; Shimamura, Janowsky, & Squire, 1990). Disruptions in temporal-order judgments that are disproportionate to disruptions in item recognition or cued recall have also been shown in Korsakoff patients (Huppert & Piercy, 1976; Meudell et al., 1985; Shimamura, Janowsky, & Squire, 1991; Squire, 1982; Squire, Nadel, & Slater, 1981). Patients with Korsakoff syndrome are often impaired in tests such as the Wisconsin Card Sorting Test (Heaton, 1981) and the Benton Verbal Fluency Test (Benton, 1968), which are sensitive to frontal-lobe pathology (e.g., Squire, 1982) and sometimes show computed tomography scans indicating frontal-lobe damage (Kopelman, 1989; Shimamura, Jernigan, & Squire, 1988). Similarly, other populations in which there may be frontal damage, namely Parkinson's disease and multiple sclerosis patients, also show deficits in temporal judgments (Beatty & Monson, 1991; Sagar, Cohen, Sullivan, Corkin, & Growdon, 1988; Sagar, Sullivan, Gabrieli, Corkin, & Growdon, 1988). Within subjects, impaired temporal-order scores may be correlated with scores on neuropsychological tests sensitive to frontal damage (Squire, 1982), but note that such a correlation is not always found (Kopelman, 1989; Shimamura et al., 1990).

Disrupted memory for the source of trivia facts also appears to be related to measures of frontal-lobe dysfunctions in some studies of amnesics (Schacter et al., 1984) and is also found in frontal-lobe patients who do not show disrupted memory for the facts themselves (Janowsky, Shimamura, & Squire, 1989). There is also evidence from both physiological and behavioral studies that the frontal cortex is particularly sensitive to the effects of aging (Albert & Kaplan, 1980; Woodruff, 1982). On the basis of these findings, McIntyre and Craik (1987) suggested that memory deficits in remembering source in older normal subjects may be linked to frontal-lobe dysfunction. Some evidence for this suggestion was provided in a recent study by Craik, Morris, Morris, and Loewen (1990), who reported a correlation in older subjects between source-monitoring scores (deciding whether a fact was learned in the experiment or outside the experiment) and performance on the Wisconsin Card Sorting Test and the Verbal Fluency Test.

In addition, disruptions in reality monitoring described in case reports of confabulation in patients suffering from organic brain disease form a systematic and suggestive picture (Johnson, 1991a). The relatively controlled lesions made in anterior cingulectomy patients produce dramatic but temporary confabulation, lasting several days (Whitty & Lewin, 1957, 1960). Damage to the basal forebrain region produces confabulation that may last weeks to months (Damasio, Graff-Radford, Eslinger, Damasio, & Kassell, 1985), and damage to various areas in the frontal lobes can produce confabulation that may last months to years (Stuss et al., 1978). Stuss et al. made a persuasive argument for the role of frontal-lobe damage in confabulation. They reported five patients with demonstrable frontal-lobe lesions who all showed spontaneous, persisting confabulation (see also Baddeley & Wilson, 1986; Kapur & Coughlan, 1980; Moscovitch, 1989). At least temporary, and sometimes long-lasting, confabulation is found in Korsakoff patients, who often show prefrontal symptomatology as well as damage to thalamic nuclei that project to prefrontal and anterior cingulate cortex. The fact that confabulators often show recognized symptoms of frontal damage such as perseverative tendencies, difficulty in shifting response sets, and lack of concern about inappropriate behavior also suggests frontal involvement. In summary, disruption of areas immediately adjacent to the frontal lobes produces marked but transient effects. Structural damage to the frontal lobes themselves produces more permanent effects. Thus, overall, there is a fairly consistent pattern of evidence pointing to confabulation as a potential consequence of disruption of frontal-lobe functioning.

Taken together, these observations of relations between disruption in frontal-lobe functions and disruptions in source monitoring in amnesic patients and older people and, particularly, confabulation in organic-brain-disease patients strongly implicate the frontal lobes in normal source-monitoring processes. As the next section argues, however, this does not mean that the frontal lobes are uniquely responsible for source memory.

Temporal and diencephalic areas. Some investigators have considered the possibility that the type of memory disruption that is associated with damage to the medial temporal lobes or diencephalon is primarily a problem of disrupted source (usually called *context*) memory (J. Brown & Brown, 1990; Hirst, 1982, 1989; Huppert & Piercy, 1976; 1978; Mayes, 1988, 1992; Mayes et al., 1985; Schacter, 1987b; Stern, 1981). According to this view, the disrupted memory for content shown in anterograde amnesia is secondary to a more fundamental disruption in source memory (e.g., context no longer provides an effective recall cue). One conceptual problem with this idea is that the cognitive processes (e.g., reactivating information and elaborating relations among items) that contribute to source or contextual information contribute to factual or content memory as well (cf. Johnson, 1992; Mayes et al., 1985). For example, improving organization among items on a particular list should both boost item recall and improve subjects' ability to correctly attribute items to that list (assuming the same organizational categories were not used for other lists). Thus, from a processing point of view, it is hard to differentiate those cognitive activities that produce good memory for content from those that produce good memory for context (Johnson, 1992).[5]

Others have argued that the memory disruption associated with temporal/diencephalic damage does not involve disruption of source memory but rather that disruptions in source memory occur as a consequence of additional frontal-lobe damage found in some temporal/diencephalic patients (e.g., Shimamura et al., 1990; Shimamura & Squire, 1987; Squire, 1982). According to this view, memory for content is a function of temporal/diencephalic regions, and memory for source is a function of frontal regions. Again, this is based on too simple a notion of the processes that are involved in both memory for content and memory for source.

We think it more likely that although the frontal lobes contribute to memory for source, they contribute to memory for content as well. Similarly, although the temporal lobes and diencephalon are critical for memory for content, they contribute to memory for source as well. Given the likely overlap in processes that promote memory for source and memory for content (see also Mayes et al., 1985), patients who have disruptions of source memory should show disrupted memory for content under some circumstances and vice versa. In keeping with this, frontal patients show disruption in content recall if they are tested in multitrial free-recall learning—a type of memory test more dependent on reflective organizational processes than the more commonly used, single-trial free-recall, cued-recall, or recognition tests, on which they show "intact" content memory (Janowsky et al. [cited in Shimamura et al., 1991]; also see Moscovitch, 1989; and Smith & Milner, 1984). Similarly, amnesics, even those without obvious frontal damage, would have poor source memory if they were directly compared with controls under the same acquisition and test conditions.

Usually, amnesics and controls are not compared under the same acquisition and test conditions. A common methodological practice is to equate patients and controls on recognition or cued recall and then compare source-monitoring scores (e.g., Cave & Squire, 1991; Meudell et al., 1985; Pickering et al., 1989; Schacter et al., 1984; cf. Hirst et al., 1986; Hirst et al., 1988). For example, amnesics might be given longer to study the items, or controls might be given a longer retention interval. Using this procedure, it is tempting to interpret a deficit in performance on a source task that is disproportionate to a deficit on the content task as demonstrating that source memory is disrupted. However, it does not follow that either content or source memory has been uniformly disrupted or that they have been localized to particular brain areas. Such a result only implies that some process or type of information is involved to a greater extent in one task than in the other. For example, predictions for a situation in which, say, recognition is equated between groups and in which source monitoring is tested would depend on the type of information used by subjects in evaluating content and source (see Source Monitoring and Old–New Recognition section). Suppose, in this particular test, both amnesics and controls used only perceptual information for making both recognition and source-monitoring judgments. If

[5] Another reason to not take as fundamental the content versus context distinction but rather to treat them as heuristic categories is that they may be impossible to separate on a priori grounds. What is core content and what is incidental context may vary with the situation, especially with a person's activated goals (e.g., Allport, 1955; Johnson, 1992; Menzel & Johnson, 1976).

the groups were equated on recognition, they would also be equated on source monitoring. Nevertheless, this would not mean that the groups would remain equated in a source-monitoring task that demanded more reflectively elaborated information for accurate performance (e.g., Weinstein, 1987, cited in Johnson, 1990). In short, whether amnesics show disproportionate deficits in source monitoring in relation to controls depends on what types of information the two groups use in the content and source tests. Similarly, the correlation within a group between recognition (or cued recall) and source-monitoring scores should depend on the extent to which subjects use similar information for the two types of tests. Because criteria are flexible and individually determined and the number of subjects per group is typically small, the size of these correlations may not be consistent across labs or even within labs.[6]

Linking aspects of source memory to different brain areas. Although both temporal/diencephalic and frontal areas contribute to memory for source, they presumably do so in different ways. One possibility is that temporal/diencephalic areas are involved in consolidating (e.g., Milner, 1970; Squire, 1987; Zola-Morgan & Squire, 1990) memory characteristics such as perceptual and spatial detail through a process of reactivating memory records (Johnson, 1992; Johnson & Hirst, 1991; cf. Spear & Mueller, 1984) and that frontal areas are involved in discovering relations among events, strategic retrieval, and setting criteria in memory tasks (e.g., Johnson, 1990; Moscovitch, 1989). As we have argued, all of these processes are important for both content and source memory. The fact that they may be important to different degrees in different situations produces the variable relation between content and source and between patterns shown by memory-disordered patients with and without frontal damage. A more general point is that given the complex processes involved in establishing particular memory characteristics relevant to source (e.g., perceptual, temporal, spatial, and affective; see the next section, Source Monitoring Within a General Memory Architecture) and the complex processes involved in source monitoring, it is unlikely that any single brain area is alone responsible for memory for source (see, also Mayes et al., 1985; Mishkin, 1982).

In summary, the source-monitoring framework suggests that disruptions in source monitoring can occur for a number of reasons, which fall into two broad categories: (a) disruption in the encoding of events initially—for example, disruption in processes that might limit encoding or consolidation of some types of perceptual, contextual, affective, semantic, and cognitive operations information—or disruption in retrieving and noting relations between prior and ongoing events that would severely limit relational information and (b) disruption in heuristic or systematic source-monitoring judgment processes—for example, when subjects do not access available relevant information, use lax or inappropriate criteria for making source decisions, or do not use heuristic and systematic processes to check each other. Such disruptions can come about, for example, when subjects at either acquisition or test are pressed for time, stressed, depressed, distracted, or under the influence of alcohol or other drugs or if they have suffered damage to certain areas of the brain. Given these more specific hypotheses about the cognitive mechanisms underlying source monitoring, it should be possible to design studies that are more analytic about exactly which of these factors might operate under various conditions and involve various brain areas. New developments in neuroimaging techniques provide increasingly precise and detailed anatomical information about cognitively impaired patients (e.g., Squire, Amaral, & Press, 1990). To maximally exploit these exciting technical developments, we need to use a correspondingly sophisticated characterization of the mental processes involved in the tasks we study.

Source Monitoring Within a General Memory Architecture

Our primary goal in this article is to illustrate that a wide variety of phenomena can be usefully discussed in a common set of terms, which suggest additional directions for empirical research. For the future, greater theoretical specificity in characterizing the memory records and processes involved in source monitoring will require embedding discussions of source monitoring within the context of a specific processing model of memory. We briefly consider what the outlines of such an approach might look like, using the Multiple-Entry, Modular (MEM) memory framework (Johnson, 1983, 1991a; Johnson & Hirst, 1991, in press; Johnson & Multhaup, 1992).

The aim of the MEM framework is to describe a relatively small set of cognitive processes (the component processes) that are jointly sufficient to account for changes in memory and performance from cognitive activity. That is, any task involves some combination of these component processes, and memory is viewed as a record of the operation of the component processes. At present, MEM consists of 16 component processes, largely derived from prior findings or concepts in the cognitive literature. These component processes are grouped into four proposed functional subsystems, two (P-1 and P-2) that are composed of perceptual processes contributing to memory records (e.g., those involved in seeing) and two (R-1 and R-2) that are composed of reflective processes, such as the self-generated activities involved in organizing and elaborating. The component processes of each subsystem are P-1 (*locating, resolving, extracting,* and *tracking*), P-2 (*placing, identifying, examining,* and *structuring*), R-1 (*reactivating, refreshing, shifting,* and *noting*), and R-2 (*retrieving, rehearsing, initiating,* and *discovering*).

Although specific processes from two or more subsystems may be analogous, in relation to P-1 and R-1, the processes of P-2 and R-2 operate on more complex data structures (Johnson & Hirst, in press). So, for example, *locating* can be applied to an undifferentiated external stimulus (Weiskrantz, 1986) whereas *placing* can compute relative positions of two differentiated and usually identified objects. Similarly, *noting* can compute overlapping relations from associations activated by two items (e.g., *dog* and *cat* both activate *animal*), whereas *discovering* finds relations that are less direct, for example, relations that depend

[6] Similarly, Sagar and colleagues (Sagar, Downes, & Mayes, 1991; Sagar, Gabrieli, Sullivan, & Corkin, 1990) have discussed the possibility that source judgments might be made in different ways—depending on such factors as the severity of a patient's recognition deficit, etiology of the amnesic deficit, and the nature of the task and matching procedure used (cf. Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991).

on other relations as in computing analogies (e.g., Gentner, 1988). The two reflective subsystems also include the capability of "executive" control and monitoring functions (e.g., Miller, Galanter, & Pribram, 1960; Norman & Shallice, 1986; Stuss & Benson, 1986). Control and monitoring functions are drawn from sets of potential *agendas*. An agenda comprises a recipe or program for cognitive action consisting of component subprocesses. Agendas are often learned and are activated by ongoing stimulus conditions, including ongoing cognitive activities. These component processes and their proposed structure serve as a basis for modeling a variety of memory phenomena (Johnson, 1983, 1990, 1991a, 1991b, 1992; Johnson & Hirst, 1991, in press; Johnson & Multhaup, 1992).

Further research may necessitate adding additional component processes, and much more work will be needed to clearly define the nature of particular components and to unambiguously differentiate among them (e.g., to know whether a particular performance involves *locating* or *placing*). Despite its provisional nature, a component-processes approach to memory has many potential benefits, especially compared with simple dichotomies such as conceptualizing processes as automatic or controlled, or data driven or conceptually driven or conceptualizing the content of memories as procedural or declarative, or semantic or episodic (Johnson & Hirst, in press). A relatively small increase in theoretical complexity in moving from any of these dichotomies to a component-processes framework, such as MEM, provides substantial increases in both specificity and generality.

MEM provides a mid-level vocabulary for integrating work from more specific theoretical and empirical efforts. For example, *locating* is explicated by research on visual–spatial attention (e.g., Yantis & Johnson, 1990), *identifying* by research on object identification (e.g., Biederman, 1987), *reactivating* by research on reinstatement effects (e.g., Rovee-Collier & Hayne, 1987), and *rehearsing* by research on working memory (Baddeley, 1986). At the same time, MEM components themselves can be used to decompose other concepts. For example, organization and elaboration (e.g., Tulving, 1962) can be described in terms of specific component processes of MEM such as *refreshing, shifting, noting,* and *reactivating* (Johnson, 1990, 1992). MEM also provides a vocabulary for discussing issues such as the cognitive activities required for the binding and consolidation of central and contextual information (Johnson, 1992), processes fundamental to determining cue effectiveness. MEM not only offers parsimonious language for describing a range of phenomena, it also provides rich enough detail to make predictions about the breakdown of functioning from brain damage, aging, and psychological distress (Johnson, 1990; Johnson & Hirst, 1991, in press).

With respect to source monitoring, MEM can be useful in conceptualizing both the memory characteristics and the decision processes discussed here. The memory characteristics (i.e., perceptual, contextual, affective, semantic, and cognitive operations) postulated by the source-monitoring framework are summary labels for the outcomes of combinations of underlying cognitive activities. Within MEM, various component subprocesses of perception (e.g., *locating, identifying,* and *tracking* stimuli and *placing* objects in spatial relations) and of reflection (e.g., *rehearsing, reactivating,* and *retrieving* events and *noting* relations among them) combine to determine what characteristics are encoded in memory. For example, affective information may arise from perceptual processes (e.g., fear arising from suddenly *locating* a stimulus in your peripheral vision) or from more reflective processes (e.g., fear arising from *discovering* an inconsistency in your argument just before it is your turn to speak; Johnson & Multhaup, 1992). Similarly, temporal aspects of memory might arise from perceptual records of *identified* objects (e.g., a moon in the memory implies that it was night) or from reflective records of *noted* relations (e.g., "I remember thinking that I also saw him as I left the seminar last week, and the seminar meets on Wednesdays"). With respect then to temporal information, records of perceptual activity may be sufficient to indicate that an event took place at night, but records of reflective activity may be necessary for specifying that an event took place on Wednesday or after another particular event (cf. Tzeng, Lee, & Wetzel, 1979).

In short, there is not a single mental computation, identifiable with a single brain region, that is responsible for affect or for temporal information (cf. Olton, 1989), spatial information (cf. Smith & Milner, 1984) and so forth. Furthermore, the MEM framework can be used to help characterize the likely complexity of the mental computations involved in encoding, reactivating, and using various memory characteristics for various purposes. An example is our earlier suggestion that frontal damage disrupts processes such as *retrieving* and *discovering* relations that would help specify that an event occurred on Wednesday or after another related event, whereas temporal/diencephalic damage disrupts *reactivation* processes critical for the consolidation even of within-event characteristics such as the perceptual information indicating that an event occurred at night. This would account for the profound absence of source-specifying information in patients with combined medial/temporal damage and frontal damage.[7]

Another aspect of MEM that is relevant to conceptualizing source attribution, and decision processes in general, is that MEM divides reflection into two subsystems, R-1 and R-2, each capable of executive control and each able to recruit processes for prolonging activation (*refreshing* and *rehearsing*), for introducing change in an activation pattern (*shifting* and *initiating*), for going back to earlier objects of perception and thought (*reactivating* and *retrieving*), and for creating relations among events (*noting* and *discovering*). Compared with R-1 processes, R-2 processes are more controlled or deliberate (systematic). The more a task draws exclusively from the set of R-1 components (and the fewer the components engaged), the less deliberate it will seem; the more it draws from R-2 components (and the more components it engages), the more deliberate it will seem. However, R-1 and R-2 do not map simply onto two discrete categories, nondeliberative and deliberative (or automatic and controlled), or to any simple dimension. As noted by Chaiken et al. (1989), a "strict automatic-controlled dichotomy is too restrictive to capture many phenomena of interest" (p. 213).

[7] Of course, medial/temporal and frontal areas of the brain are complex structures; different component processes of MEM very likely are differentially supported by or distributed across various substructures of these more general regions.

Thus, rather than using terms that imply a unidimensional analysis of cognition, *R-1* and *R-2* can be used as shorthand terms to refer, respectively, to prototypical types of heuristic (relatively automatic) and systematic (relatively controlled) processing drawn from a multiply determined family of processing possibilities (e.g., Johnson, 1991a; Johnson & Hirst, in press; Kahan & Johnson, 1992). An advantage of the terms *R-1* and *R-2* is that they are not proposed as primitives and can remind us that the task ahead is to further decompose concepts such as "control" into component processes such as those specified in MEM.

Dividing reflection into two cohesive subsystems (R-1 and R-2) has a number of advantages similar to advantages gained from computer software designed to execute as cooperating processes: It easily allows two agendas to be engaged at once. For example, source monitoring can simultaneously involve assessing qualitative characteristics of activated information through R-1 processes and retrieving additional information to check plausibility through R-2 processes. Dividing reflection into two subsystems provides a way of understanding how some aspects of reflection might be disrupted without fully disorganizing thought (e.g., Johnson, 1991a; Johnson & Hirst, in press). Hence, the disruption of R-2 processes evident in divided attention tasks or in some frontal patients may disrupt some aspects of source monitoring without disrupting other aspects of memory. An equally important idea represented in MEM is that R-1 and R-2 also normally interact, that is, they call on each other's agendas and evaluate the outcomes of processes. Thus the outcomes of heuristic and systematic processes can correct each other, as when vivid mental experiences do not pass a plausibility check in source monitoring. More generally, working together, R-1 and R-2 yield the experience of thinking about thinking. Such a conceptual organization of reflective processes provides a way of discussing how the phenomenal experience of control, intention, and agency might arise and suggests mechanisms underlying self-awareness (Johnson, 1991b; Johnson & Hirst, in press).

We believe that this component-process approach has advantages over both structural models and processing dichotomies. The brief overview of MEM offered here is not intended to fully explicate the model but rather to communicate the general flavor of the component-process approach. Interested readers are referred to Johnson (1990, 1991a, 1991b, 1992) and Johnson and Hirst (in press) for more detailed presentations.

Conclusions

Source monitoring is a critical everyday memory function. The feeling that a memory has a specific source is a compelling reason for experiencing it as belonging to our personal past. Furthermore, source-monitoring processes differentiate fact from fantasy in remembering (e.g., whether your neighbors yelled at you or you only imagined they might), reliable from unreliable sources of information (e.g., your doctor vs. the *National Enquirer* for nutrition tips), and actions from intentions (e.g., taking pills vs. only thinking about it). Disruption in any or all of these situations has serious implications both in potential impact on event memory and on development and use of knowledge and beliefs.

In this article, we outlined an integrative theoretical framework for understanding the processes involved in source monitoring. A consideration of recent findings and theorizing in a number of domains suggests that this framework can point to connections among diverse phenomena. Ultimately, however, the value of such a framework lies in the extent to which it helps explain otherwise confusing results and guides future research in a meaningful direction.

We believe that the framework has been helpful in accounting for disparate results. For example, the framework can explain why under some circumstances performance on recognition memory and source tests are dissociated, whereas under other conditions they are correlated. In addition, it predicts the dissociations as well as parallel effects found in studying the relation between direct and indirect tests of memory. Similarly, it can account for why in some situations memory-disordered patients have difficulty in remembering both source and content, whereas in other situations the source deficit occurs in the absence of a deficit in remembering content. The framework also suggests factors that determine whether misleading information will affect memory for recently experienced events and whether people will misattribute familiarity to prior knowledge (e.g., the false-fame effect), will show cryptomnesia, or will be influenced by fictional information.

As a general research strategy, the framework suggests considering both memory characteristics and decision processes in source monitoring and encourages investigating different source-monitoring situations under comparable conditions or in the same subject populations. It also suggests several specific research questions. For example, can the boundary conditions for appropriating fictional information into one's knowledge base or using it later be related to specific component processes involved in processing information? To what extent do developmental changes in source monitoring reflect growth of more complex heuristic and systematic reflective processing, such as the ability to combine information from two or more dimensions or the ability to engage in strategic retrieval? Can a source-monitoring analysis contribute to the understanding of differences in susceptibility to misleading information between young adults and children or between young adults and older adults? To what extent do deficits in source monitoring experienced by older adults arise from difficulties in encoding or reviving particular aspects of memories or from the criteria they adopt in source-monitoring decisions? Can differences in source-monitoring problems among various brain-damaged or memory-disordered populations be identified and classified? And can differences between patients in source amnesia, types of delusions, confabulation, source misattributions, and other source-monitoring phenomena be understood in terms of different combinations of disruption of memory characteristics and decision processes? Finally, can progress be made in relating factors that cognitive studies have identified as important for source monitoring to underlying brain structures or mechanisms? Questions such as these provide exciting new opportunities for understanding the critical cognitive function of source monitoring.

References

Abra, J. C. (1972). List differentiation and forgetting. In C. P. Duncan, L. Sechrest, & A. W. Melton (Eds.), *Human memory: Festschrift in* *honor of Benton J. Underwood* (pp. 25–57). New York: Appleton-Century-Crofts.

Alba, J. W., & Hasher, L. (1983). Is memory schematic? *Psychological Bulletin, 93,* 203–231.

Albert, M. S., & Kaplan, E. (1980). Organic implications of neuropsychological deficits in the elderly. 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 A. Talland Memorial Conference* (pp. 403–432). Hillsdale, NJ: Erlbaum.

Allport, F. H. (1955). *Theories of perception and the concept of structure.* New York: Wiley.

Anderson, J. R., & Bower, G. H. (1972). Recognition and retrieval processes in free recall. *Psychological Review, 79,* 97–123.

Anderson, J. R., & Bower, G. H. (1974). A propositional theory of recognition memory. *Memory & Cognition, 2,* 406–412.

Anderson, J. R., & Ross, B. H. (1980). Evidence against a semantic–episodic distinction. *Journal of Experimental Psychology: Human Learning and Memory, 6,* 441–465.

Anderson, R. E. (1984). Did I do it or did I only imagine doing it? *Journal of Experimental Psychology: General, 113,* 594–613.

Atkinson, R. C., & Juola, J. F. (1973). Factors influencing speed and accuracy of word recognition. In S. Kornblum (Ed.), *Attention and Performance IV* (pp. 583–612). San Diego, CA: Academic Press.

Baddeley, A. (1986). *Working memory: Oxford Psychology Series No. 11.* London: Oxford University Press.

Baddeley, A. D., & Wilson, B. (1986). Amnesia, autobiographical memory and confabulation. In D. Rubin (Ed.), *Autobiographical memory* (pp. 225–252). New York: Cambridge University Press.

Batchelder, W. H., & Riefer, D. M. (1990). Multinomial processing models of source monitoring. *Psychological Review, 97,* 548–564.

Beatty, W. W., & Monson, N. (1991). Memory for temporal order in multiple sclerosis. *Bulletin of the Psychonomic Society, 29,* 10–12.

Begg, I., & Armour, V. (1991). Repetition and the ring of truth: Biasing comments. *Canadian Journal of Behavioral Science, 23,* 195–213.

Begg, I. M., Robertson, R. K., Gruppuso, V., Anas, A., & Needham, D. R. (1992). *The illusory-knowledge effect.* Manuscript submitted for publication.

Belli, R. F., Lindsay, D. S., Gales, M. S., & McCarthy, T. T. (1992). *Memory impairment and source misattribution in postevent misinformation experiments with short retention intervals.* Manuscript submitted for publication.

Belli, R. F., Windschitl, P. D., McCarthy, T. T., & Winfrey, S. E. (1992). Detecting memory impairment with a modified test procedure: Manipulating retention interval with centrally presented event items. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 356–367.

Bentall, R. P. (1990). The illusion of reality: A review and integration of psychological research on hallucinations. *Psychological Bulletin, 107,* 82–95.

Benton, A. L. (1968). Differential behavioral effects in frontal lobe disease. *Neuropsychologia, 6,* 53–60.

Biederman, I. (1987). Recognition-by-components: A theory of human image understanding. *Psychological Review, 94,* 115–147.

Bransford, J. D., & Franks, J. J. (1971). The abstraction of linguistic ideas. *Cognitive Psychology, 2,* 331–350.

Bransford, J. D., Franks, J. J., Morris, C. D., & Stein, B. S. (1979). Some general constraints on learning and memory research. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 331–354). Hillsdale, NJ: Erlbaum.

Brenner, M. (1973). The next-in-line effect. *Journal of Verbal Learning and Verbal Behavior, 12,* 320–323.

Brown, A. S., & Murphy, D. R. (1989). Cryptomnesia: Delineating inadvertent plagiarism. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 432–442.

Brown, J., & Brown, M. W. (1990). The effects of repeating a recognition test in Lorazepam-induced amnesia: Evidence for impaired contextual memory as a cause of amnesia. *Quarterly Journal of Experimental Psychology, 42A,* 279–290.

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

Cave, C. B., & Squire, L. R. (1991). Equivalent impairment of spatial and nonspatial memory following damage to the human hippocampus. *Hippocampus, 1,* 329–340.

Ceci, S. J., & Bruck, M. (1993). The suggestibility of the child witness: A historical review and synthesis. *Psychological Bulletin, 113,* 403–439.

Ceci, S. J., Ross, D. F., & Toglia, M. P. (1987). Suggestibility of children's memory: Psychological implications. *Journal of Experimental Psychology: General, 116,* 38–49.

Chaiken, S., Lieberman, A., & Eagly, A. H. (1989). Heuristic and systematic information processing within and beyond the persuasion context. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 212–252). New York: Guilford Press.

Chandler, C. C. (1991). How memory for an event is influenced by related events: Interference in modified recognition tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17,* 115–125.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology, 4,* 55–81.

Cohen, G., & Faulkner, D. (1989). Age differences in source forgetting: Effects on reality monitoring and on eyewitness testimony. *Psychology and Aging, 4,* 10–17.

Corbett, A. T., & Dosher, B. A. (1978). Instrument inferences in sentence encoding. *Journal of Verbal Learning and Verbal Behavior, 17,* 479–481.

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. (1989). On the making of episodes. In H. L. Roediger III & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 43–57). Hillsdale, NJ: Erlbaum.

Craik, F. I. M., & Kirsner, K. (1974). The effects of speaker's voice on word recognition. *Quarterly Journal of Experimental Psychology, 26,* 274–284.

Craik, F. I. M., Morris, L. W., Morris, R. G., & Loewen, E. R. (1990). Relations between source amnesia and frontal lobe functioning in older adults. *Psychology and Aging, 5,* 148–151.

Cramer, P. (1965). Recovery of a discrete memory. *Journal of Personality and Social Psychology, 1,* 326–332.

Damasio, A. R., Graff-Radford, N. R., Eslinger, P. J., Damasio, H., & Kassell, N. (1985). Amnesia following basal forebrain lesions. *Archives of Neurology, 42,* 263–271.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58,* 17–22.

Dodson, C. S., & Johnson, M. K. (in press). The rate of false source attributions depends on how questions are asked. *American Journal of Psychology.*

Dominowski, R. L., & Ekstrand, B. R. (1967). Direct and associative priming in anagram solving. *Journal of Experimental Psychology, 74,* 84–86.

Dosher, B. A. (1984). Degree of learning and retrieval speed: Study time and multiple exposures. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10,* 541–574.

Durso, F. T., & Johnson, M. K. (1980). The effects of orienting tasks on recognition, recall, and modality confusion of pictures and words. *Journal of Verbal Learning and Verbal Behavior, 19,* 416–429.

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

Durso, F. T., Reardon, R., Shore, W. J., & Delys, S. M. (1991). Memory processes and hypochondriacal tendencies. *Journal of Nervous and Mental Disease, 179,* 279–283.

Dywan, J., & Jacoby, L. (1990). Effects of aging on source monitoring: Differences in susceptibility to false fame. *Psychology and Aging, 5,* 379–387.

Eich, J. E. (1980). The cue-dependent nature of state-dependent retrieval. *Memory & Cognition, 8,* 157–173.

Eich, E. (1984). Memory for unattended events: Remembering with and without awareness. *Memory & Cognition, 12,* 105–111.

Eich, E., & Metcalfe, J. (1989). Mood dependent memory for internal versus external events. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 443–455.

Ferguson, S., Hashtroudi, S., & Johnson, M. K. (1992). Age differences in using source-relevant cues. *Psychology and Aging, 7,* 443–452.

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

Fisher, R. P., & Cuervo, A. (1983). Memory for physical features of discourse as a function of their relevance. *Journal of Experimental Psychology: Human Learning, Memory, and Cognition, 9,* 130–138.

Flavell, J. H. (1985). *Cognitive development* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Foley, M. A., Aman, C., & Gutch, D. (1987). Discriminating between action memories: Children's use of kinesthetic cues and visible consequences. *Journal of Experimental Child Psychology, 44,* 335–347.

Foley, M. A., Durso, F. T., Wilder, A., & Freidman, R. (1991). Developmental comparisons of explicit versus implicit imagery and reality monitoring. *Journal of Experimental Child Psychology, 51,* 1–13.

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

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

Foley, M. A., Santini, C., & Sopasakis, M. (1989). Discriminating between memories: Evidence for children's spontaneous elaborations. *Journal of Experimental Child Psychology, 48,* 146–169.

Gardiner, J. M. (1989). A generation effect in memory without awareness. *British Journal of Psychology, 80,* 163–168.

Geiselman, R. E., & Belleza, F. S. (1976). Long-term memory for speaker's voice and source location. *Memory & Cognition, 4,* 483–489.

Geiselman, R. E., & Belleza, F. S. (1977). Incidental retention of speaker's voice. *Memory & Cognition, 5,* 658–665.

Gentner, D. (1988). Analogical inference and analogical access. In A. Prieditis (Ed.), *Analogica* (pp. 63–88). Los Altos, CA: Morgan Kaufmann.

Gerrig, R. J., & Prentice, D. A. (1990). *The incorporation of fictional information into real-world knowledge.* Unpublished manuscript.

Gerrig, R. J., & Prentice, D. A. (1991). The representation of fictional information. *Psychological Science, 2,* 336–340.

Gillund, G., & Shiffrin, R. M. (1984). A retrieval model for both recognition and recall. *Psychological Review, 91,* 1–67.

Godden, D. R., & Baddeley, A. D. (1975). Context-dependent memory in two natural environments: On land and underwater. *British Journal of Psychology, 66,* 325–331.

Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. *Journal of Verbal Learning and Verbal Behavior, 23,* 553–568.

Graf, P., Shimamura, A. P., & Squire, L. R. (1985). Priming across modalities and priming across category levels: Extending the domain of preserved function in amnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11,* 386–396.

Graf, P., Squire, L. R., & Mandler, G. (1984). The information that amnesic patients do not forget. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10,* 164–178.

Guttentag, R. E., & Hunt, R. R. (1988). Adult age differences in memory for imagined and performed actions. *Journal of Gerontology, 43,* 107–108.

Hanley, G. L., & Collins, V. L. (1989). Metamemory judgments of the origin and content of course information: Comparing text and lecture materials. *Journal of Educational Psychology, 81,* 3–8.

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

Hasher, L., Goldstein, D., & Toppino, T. (1977). Frequency and the conference of referential validity. *Journal of Verbal Learning and Verbal Behavior, 16,* 107–112.

Hasher, L., & Griffin, M. (1978). Reconstructive and reproductive processes in memory. *Journal of Experimental Psychology: Human Learning and Memory, 4,* 318–330.

Hasher, L., & Zacks, R. T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General, 108,* 356–388.

Hashtroudi, S., Ferguson, S. A., Rappold, V. A., & Chrosniak, L. D. (1988). Data-driven and conceptually driven processes in partial-word identification and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 749–757.

Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1989). Aging and source monitoring. *Psychology and Aging, 4,* 106–112.

Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1990). Aging and qualitative characteristics of memories for perceived and imagined complex events. *Psychology and Aging, 5,* 119–126.

Heaton, R. K. (1981). *A manual for the Wisconsin Card Sorting Test.* Odessa, FL: Psychological Assessment Resources.

Hilgard, E. R. (1977). Controversies over consciousness and the rise of cognitive psychology. *Australian Psychologist, 12,* 7–26.

Hintzman, D. L. (1988). Judgments of frequency and recognition memory in a multiple-trace memory model. *Psychological Review, 95,* 528–551.

Hintzman, D. L., Block, R. A., & Inskeep, N. R. (1972). Memory for mode of input. *Journal of Verbal Learning and Verbal Behavior, 11,* 741–749.

Hintzman, D. L., Block, R. A., & Summers, J. J. (1973). Contextual associations and memory for serial position. *Journal of Experimental Psychology, 97,* 220–229.

Hirst, W. (1982). The amnesic syndrome: Descriptions and explanations. *Psychological Bulletin, 91,* 435–460.

Hirst, W. (1989). On consciousness, recall, recognition, and the architecture of memory. In S. Lewandowsky, J. C. Dunn, & K. Kirsner (Eds.), *Implicit memory: Theoretical issues* (pp. 33–46). Hillsdale, NJ: Erlbaum.

Hirst, W., Johnson, M. K., Kim, J. K., Phelps, E. A., Risse, G., & Volpe, B. T. (1986). Recognition and recall in amnesics. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 445–451.

Hirst, W., Johnson, M. K., Phelps, E. A., & Volpe, B. T. (1988). More on recognition and recall in amnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 758–762.

Hirst, W., & Volpe, B. T. (1982). Temporal order judgments with amnesia. *Brain and Cognition, 1,* 294–306.

Hirst, W., & Volpe, B. T. (1984). Encoding of spatial relations with amnesia. *Neuropsychologia, 22,* 631–634.

Hirt, E. R. (1990). Do I see only what I expect? Evidence for an expectancy-guided retrieval model. *Journal of Personality and Social Psychology, 58,* 937–951.

Horowitz, M. J. (1978). *Image formation and cognition* (2nd ed.). New York: Appleton-Century-Crofts.

Hultsch, D. F., & Dixon, R. A. (1990). Learning and memory in aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (3rd ed., pp. 258–274). San Diego, CA: Academic Press.

Huppert, F. A., & Piercy, M. (1976). Recognition memory in amnesic patients: Effects of temporal context and familiarity of material. *Cortex, 12,* 3–20.

Huppert, F. A., & Piercy, M. (1978). The role of trace strength in recency and frequency judgments by amnesic and control subjects. *Quarterly Journal of Experimental Psychology, 30,* 347–354.

Intons-Peterson, M. J., & Smyth, M. M. (1987). The anatomy of repertory memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 490–500.

Intraub, H., & Hoffman, J. E. (1992). Reading and visual memory: Remembering scenes that were never seen. *American Journal of Psychology, 105,* 101–114.

Jacoby, L. L. (1983). Remembering the data: Analyzing interactive processes in reading. *Journal of Verbal Learning and Verbal Behavior, 22,* 485–508.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30,* 513–541.

Jacoby, L. L., & Brooks, L. R. (1984). Nonanalytic cognition: Memory, perception, & concept learning. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 18, pp. 1–47). San Diego, CA: Academic Press.

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General, 110,* 306–340.

Jacoby, L. L., & Kelley, C. M. (1990). An episodic view of motivation: Unconscious influences of memory. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 451–481). New York: Guilford Press.

Jacoby, L. L., & Kelley, C. M. (1992). Unconscious influences of memory: Dissociations and automaticity. In D. Milner & M. Rugg (Eds.), *The neuropsychology of consciousness* (pp. 201–233). San Diego, CA: Academic Press.

Jacoby, L. L., Kelley, C., Brown, J., & Jasechko, J. (1989). Becoming famous overnight: Limits on the ability to avoid unconscious influences of the past. *Journal of Personality and Social Psychology, 56,* 326–338.

Jacoby, L. L., Kelley, C. M., & Dywan, J. (1989). Memory attributions. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 391–422). Hillsdale, NJ: Erlbaum.

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General, 118,* 126–135.

Jacoby, L. L., Woloshyn, V., & Kelley, C. (1989). Becoming famous without being recognized: Unconscious influences of memory produced by dividing attention. *Journal of Experimental Psychology: General, 118,* 115–125.

Janowsky, J. S., Shimamura, A. P., & Squire, L. R. (1989). Source memory impairment in patients with frontal lobe lesions. *Neuropsychologia, 27,* 1043–1056.

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

Johnson, M. K. (1985). The origin of memories. In P. C. Kendall (Ed.), *Advances in cognitive-behavioral research and therapy* (Vol. 4, pp. 1–26). San Diego, CA: Academic Press.

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

Johnson, M. K. (1988b). Reality monitoring: An experimental phenomenological approach. *Journal of Experimental Psychology: General, 117,* 390–394.

Johnson, M. K. (1990). Functional forms of human memory. In J. L. McGaugh, N. M. Weinberger, & G. Lynch (Eds.), *Brain organization and memory: Cells, systems and circuits* (pp. 106–134). New York: Oxford University Press.

Johnson, M. K. (1991a). Reality monitoring: Evidence from confabulation in organic brain disease patients. In G. P. Prigatano & D. L. Schacter (Eds.), *Awareness of deficit after brain injury: Clinical and theoretical issues* (pp. 176–197). New York: Oxford University Press.

Johnson, M. K. (1991b). Reflection, reality monitoring and the self. In R. Kunzendorf (Ed.), *Mental imagery: Proceedings of the Eleventh Annual Conference of the American Association for the Study of Mental Imagery* (pp. 3–16). New York: Plenum Press.

Johnson, M. K. (1992). MEM: Mechanisms of recollection. *Journal of Cognitive Neuroscience, 4,* 268–280.

Johnson, M. K., Bransford, J. D., & Solomon, S. K. (1973). Memory for tacit implications of sentences. *Journal of Experimental Psychology, 98,* 203–205.

Johnson, M. K., & Foley, M. A. (1984). Differentiating fact from fantasy: The reliability of children's memory. *Journal of Social Issues, 40*(2), 33–50.

Johnson, M. K., Foley, M. A., & Leach, K. (1988). The consequences for memory of imagining in another person's voice. *Memory & Cognition, 16,* 337–342.

Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General, 117,* 371–376.

Johnson, M. K., & Hirst, W. (1991). Processing subsystems of memory. In R. G. Lister & H. J. Weingartner (Eds.), *Perspectives on cognitive neuroscience* (pp. 197–217). New York: Oxford University Press.

Johnson, M. K., & Hirst, W. (in press). MEM: Memory subsystems as processes. In A. Collins, M. Conway, S. Gathercole, & P. Morris (Eds.), *Theories of memory.* Hillsdale, NJ: Erlbaum.

Johnson, M. K., Hirst, W., Phelps, E. A., Multhaup, K. S., & Volpe, B. (1992). *Source monitoring and amnesia.* Manuscript in preparation.

Johnson, M. K., Kahan, T. L., & Raye, C. L. (1984). Dreams and reality monitoring. *Journal of Experimental Psychology: General, 113,* 329–344.

Johnson, M. K., Kim, J. K., & Risse, G. (1985). Do alcoholic Korsakoff's syndrome patients acquire affective reactions? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11,* 22–36.

Johnson, M. K., Kounios, J., & Reeder, J. A. (1992, November). *Time course studies of reality monitoring and recognition.* Paper presented at the 33rd annual meeting of the Psychonomic Society, St. Louis, MO.

Johnson, M. K., & Multhaup, K. S. (1992). Emotion and MEM. In S.-A. Christianson (Ed.), *The handbook of emotion and memory: Current research and theory* (pp. 33–66). Hillsdale, NJ: Erlbaum.

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

Johnson, M. K., Raye, C. L., Foley, H. J., & Foley, M. A. (1981). Cognitive operations and decision bias in reality monitoring. *American Journal of Psychology, 94,* 37–64.

Johnson, M. K., Raye, C. L., Foley, M. A., & Kim, J. K. (1982). Pictures and images: Spatial and temporal information compared. *Bulletin of the Psychonomic Society, 19,* 23–26.

Johnson, M. K., Raye, C. L., Wang, A. Y., & Taylor, T. H. (1979). Fact and fantasy: The roles of accuracy and variability in confusing imaginations with perceptual experiences. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 229–240.

Johnson, M. K., & Sherman, S. J. (1990). Constructing and reconstructing the past and the future in the present. In E. T. Higgins, & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 482–526). New York: Guilford Press.

Kahan, T. L., & Johnson, M. K. (1990). Memory for seen and imagined rotations of alphanumeric characters. *Journal of Mental Imagery, 14,* 119–130.

Kahan, T. L., & Johnson, M. K. (1992). Self effects in memory for person information. *Social Cognition, 10*(1), 30–50.

Kapur, N., & Coughlan, A. K. (1980). Confabulation and frontal lobe dysfunction. *Journal of Neurology, Neurosurgery, and Psychiatry, 43,* 461–463.

Kausler, D. H., Lichty, W., & Freund, J. S. (1985). Adult age differences in recognition memory and frequency judgments 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. (1981). Adult age differences in memory for sex of voice. *Journal of Gerontology, 36,* 44–50.

Kelley, C. M., & Jacoby, L. L. (1990). The construction of subjective experience: Memory attributions. *Mind and Language, 5,* 49–68.

Kelley, C. M., & Jacoby, L. L. (1993). *Past experience spoils judgments of problem difficulty: Analytic vs. nonanalytic bases for judgments.* Manuscript in preparation.

Kelley, C. M., Jacoby, L. L., & Hollingshead, A. (1989). Direct versus indirect tests of memory for source: Judgments of modality. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 1101–1108.

Kelley, C. M., & Lindsay, D. S. (1993). Remembering mistaken for knowing: Ease of retrieval as a basis for confidence in answers to general knowledge questions. *Journal of Memory and Language, 32,* 1–24.

Kihlstrom, J. F. (1980). Posthypnotic amnesia for recently learned material: Interactions with "episodic" and "semantic" memory. *Cognitive Psychology, 12,* 227–251.

Kirsner, K. (1974). Modality differences in recognition memory for words and their attributes. *Journal of Experimental Psychology, 102,* 579–584.

Kirsner, K., & Smith, M. C. (1974). Modality effects in word identification. *Memory & Cognition, 2,* 637–640.

Kolers, P. A. (1976). Reading a year later. *Journal of Experimental Psychology: Human Learning and Memory, 2,* 554–565.

Kolers, P. A., & Roediger, H. L., III (1984). Procedures of mind. *Journal of Verbal Learning and Verbal Behavior, 23,* 425–449.

Kopelman, M. D. (1989). Remote and autobiographical memory, temporal context memory and frontal atrophy in Korsakoff and Alzheimer patients. *Neuropsychologia, 27,* 437–460.

Kubovy, M. (1977). Response availability and the apparent spontaneity of numerical choices. *Journal of Experimental Psychology: Human Perception and Performance, 3,* 359–364.

Kunst-Wilson, W. R., & Zajonc, R. B. (1980). Affective discrimination of stimuli that cannot be recognized. *Science, 207,* 557–558.

Kunzendorf, R. G. (1985–1986). Hypnotic hallucinations as "unmonitored" images: An empirical study. *Imagination, Cognition and Personality, 5,* 255–270.

Light, L. L., & Singh, A. (1987). Implicit and explicit memory in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 531–541.

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

Lindsay, D. S. (1990). Misleading suggestions can impair eyewitnesses' ability to remember event details. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16,* 1077–1083.

Lindsay, D. S. (in press). Memory source monitoring and eyewitness testimony. In D. F. Ross, J. D. Read, & M. P. Toglia (Eds.), *Adult eyewitness testimony: Current trends and developments.*

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.

Lindsay, D. S., & Johnson, M. K. (1989). The eyewitness suggestibility effect and memory for source. *Memory & Cognition, 17,* 349–358.

Lindsay, D. S., & Johnson, M. K. (1991). Recognition memory and source monitoring. *Bulletin of the Psychonomic Society, 29,* 203–205.

Lindsay, D. S., Johnson, M. K., & Kwon, P. (1991). Developmental changes in memory source monitoring. *Journal of Experimental Child Psychology, 52,* 297–318.

Loftus, E. F. (1979a). *Eyewitness testimony.* Cambridge, MA: Harvard University Press.

Loftus, E. F. (1979b). Reactions to blatantly contradictory information. *Memory & Cognition, 7,* 368–374.

Loftus, E. F., Donders, K., Hoffman, H. G., & Schooler, J. W. (1989). Creating new memories that are quickly accessed and confidently held. *Memory & Cognition, 17,* 607–616.

Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review, 87,* 252–271.

Mandler, G. (1991). Your face looks familiar but I can't remember your name: A review of dual process theory. In W. E. Hockley & S. Lewandowsky (Eds.), *Relating theory and data: Essays on human memory in honor of Bennet B. Murdock* (pp. 207–225). Hillsdale, NJ: Erlbaum.

Mandler, G., Nakamura, Y., & Van Zandt, B. J. S. (1987). Nonspecific effects of exposure on stimuli that cannot be recognized. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 646–648.

Markham, R. (1991). Development of reality monitoring for performed and imagined actions. *Perceptual and Motor Skills, 72,* 1347–1354.

Masson, M. E. J. (1989). Fluent reprocessing as an implicit expression of memory for experience. In S. Lewandowsky, J. C. Dunn, & K. Kirsner (Eds.), *Implicit memory: Theoretical issues* (pp. 123–138). Hillsdale, NJ: Erlbaum.

Mayes, A. R. (1988). *Human organic memory disorders.* Cambridge, England: Cambridge University Press.

Mayes, A. R. (1992). What are the functional deficits that underlie amnesia? In L. R. Squire & N. Butters (Eds.), *Neuropsychology of memory* (2nd ed., pp. 23–35). New York: Guilford Press.

Mayes, A. R., Meudell, P. R., & MacDonald, C. (1991). Disproportionate intentional spatial-memory impairments in amnesia. *Neuropsychologia, 29,* 771–784.

Mayes, A. R., Meudell, P. R., & Pickering, A. (1985). Is organic amnesia caused by a selective deficit in remembering contextual information? *Cortex, 21,* 167–202.

McCloskey, M., & Zaragoza, M. (1985). Postevent information and memory: Reply to Loftus, Schooler, and Wagenaar. *Journal of Experimental Psychology: General, 114,* 381–387.

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

Menzel, E. W., & Johnson, M. K. (1976). Communication and cognitive organization in humans and other animals. In S. R. Harnad, H. D. Steklis, & J. Lancaster (Eds.), *Annals of the New York Academy of Sciences: Vol. 280. Origins and evolution of language and speech* (pp. 131–142). New York: New York Academy of Sciences.

Meudell, P. R., Mayes, A. R., Ostergaard, A., & Pickering, A. (1985). Recency and frequency judgements in alcoholic amnesics and normal people with poor memory. *Cortex, 21,* 487–511.

Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior.* New York: Holt, Rinehart & Winston.

Milner, B. (1970). Memory and the medial temporal regions of the brain. In K. H. Pribram & D. E. Broadbent (Eds.), *Biology of memory* (pp. 29–50). San Diego, CA: Academic Press.

Milner, B. (1971). Interhemispheric differences in the localization of psychological processes in man. *British Medical Bulletin, 27,* 272–277.

Milner, B., Petrides, M., & Smith, M. L. (1985). Frontal lobes and the temporal organization of memory. *Human Neurobiology, 4,* 137–142.

Mishkin, M. A. (1982). A memory system in the monkey. *Philosophical Transaction of the Royal Society of London, 298B,* 85–95.

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.

Moscovitch, M. (1989). Confabulation and the frontal systems: Strategic versus associative retrieval in neuropsychological theories of memory. In H. L. Roediger III & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 133–160). Hillsdale, NJ: Erlbaum.

Neely, J. H., & Payne, D. G. (1983). A direct comparison of recognition failure rates for recallable names in episodic and semantic memory tests. *Memory & Cognition, 11,* 161–171.

Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. J. Davidson, G. E. Schwartz, & D. Shapiro (Eds.), *Consciousness and self-regulation* (Vol. 4, pp. 1–18). New York: Plenum Press.

Oltmanns, T. F., & Maher, B. A. (Eds.). (1988). *Delusional beliefs.* New York: Wiley.

Olton, D. S. (1989). Inferring psychological dissociations from experimental dissociations: The temporal context of episodic memory. In H. L. Roediger III & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 161–177). Hillsdale, NJ: Erlbaum.

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

Perky, C. W. (1910). An experimental study of imagination. *American Journal of Psychology, 21,* 422–452.

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.

Pickering, A., Mayes, A. R., & Fairbairn, A. F. (1989). Amnesia and memory for modality information. *Neuropsychologia, 27,* 1249–1259.

Posner, M. I., & Snyder, C. R. R. (1975). Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola symposium* (pp. 55–85). Hillsdale, NJ: Erlbaum.

Potts, G. R., & Peterson, S. B. (1985). Incorporation versus compartmentalization in memory for discourse. *Journal of Memory and Language, 24,* 107–118.

Potts, G. R., St. John, M. F., & Kirson, D. (1989). Incorporating new information into existing world knowledge. *Cognitive Psychology, 21,* 303–333.

Pratkanis, A. R., Greenwald, A. G., Leippe, M. R., & Baumgardner, M. H. (1988). In search of reliable persuasion effects: III. The sleeper effect is dead. Long live the sleeper effect. *Journal of Personality and Social Psychology, 54,* 203–218.

Rabinowitz, J. C. (1989). Judgments of origin and generation effects: Comparisons between young and elderly adults. *Psychology and Aging, 4,* 259–268.

Rappold, V. A., & Hashtroudi, S. (1991). Does organization improve priming? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17,* 103–114.

Raye, C. L. (1976). Recognition: Frequency or organization? *American Journal of Psychology, 89,* 645–658.

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.

Reed, A. V. (1973). Speed–accuracy trade-off in recognition memory. *Science, 181,* 574–576.

Richardson-Klavehn, A., & Bjork, R. A. (1988). Measures of memory. *Annual Review of Psychology, 39,* 475–543.

Roediger, H. L., III, & Blaxton, T. A. (1987a). Effects of varying modality, surface features, and retention interval on priming in word-fragment completion. *Memory & Cognition, 15,* 379–388.

Roediger, H. L., III, & Blaxton, T. A. (1987b). Retrieval modes produce dissociations in memory for surface information. In D. S. Gorfein & R. R. Hoffman (Eds.), *Memory and learning: The Ebbinghaus centennial conference* (pp. 349–379). Hillsdale, NJ: Erlbaum.

Roediger, H. L., III, Weldon, M. S., & Challis, B. H. (1989). Explaining dissociations between implicit and explicit measures of retention: A processing account. In H. L. Roediger III & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 3–41). Hillsdale, NJ: Erlbaum.

Ross, D. F., Read, J. D., & Toglia, M. P. (Eds.). (in press). *Adult eyewitness testimony: Current trends and developments.*

Ross, M. (1989). Relation of implicit theories to the construction of personal histories. *Psychological Review, 96,* 341–357.

Rothkopf, E. Z. (1971). Incidental memory for location of information in text. *Journal of Verbal Learning and Verbal Behavior, 10,* 608–613.

Rovee-Collier, C., & Hayne, H. (1987). Reactivation of infant memory: Implications for cognitive development. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 20, pp. 185–238). San Diego, CA: Academic Press.

Rubin, D. C. (Ed.). (1986). *Autobiographical memory.* New York: Cambridge University Press.

Sagar, H. J., Cohen, N. J., Sullivan, E. V., Corkin, S., & Growdon, J. H. (1988). Remote memory function in Alzheimer's disease and Parkinson's disease. *Brain, 111,* 185–206.

Sagar, H. J., Downes, J., & Mayes, A. (1991, July). *Dissociations among processes of temporal order judgment.* Paper presented at the International Conference on Memory, Lancaster University, Lancaster, U.K.

Sagar, H. J., Gabrieli, J. D. E., Sullivan, E. V., & Corkin, S. (1990). Recency and frequency discrimination in the amnesic patient H.M. *Brain, 113,* 581–602.

Sagar, H. J., Sullivan, E. V., Gabrieli, J. D. E., Corkin, S., & Growdon, J. H. (1988). Temporal ordering and short-term memory deficits in Parkinson's disease. *Brain, 111,* 525–539.

Schacter, D. L. (1987a). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 501–518.

Schacter, D. L. (1987b). Memory, amnesia, and frontal lobe dysfunction. *Psychobiology, 15,* 21–36.

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.

Schacter, D. L., Kaszniak, A. W., Kihlstrom, J. F., & Valdiserri, M. (1991). The relation between source memory and aging. *Psychology and Aging, 6,* 559–568.

Schacter, D. L., & Tulving, E. (1982). Memory, amnesia, and the episodic/semantic distinction. In R. L. Isaacson & N. E. Spear (Eds.), *The expression of knowledge* (pp. 33–65). New York: Plenum Press.

Schooler, J. W., & Engstler-Schooler, T. Y. (1990). Verbal overshadowing of visual memories: Some things are better left unsaid. *Cognitive Psychology, 22,* 36–71.

Schooler, J. W., Gerhard, D., & Loftus, E. F. (1986). Qualities of the unreal. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 171–181.

Seamon, J. G., Brody, N., & Kauff, D. M. (1983). Affective discrimination of stimuli that are not recognized: Effects of shadowing, masking, and cerebral laterality. *Journal of Experimental Psychology: Human Learning, Memory, and Cognition, 9,* 544–555.

Segal, S. J. (1970). Imaging and reality: Can they be distinguished? In W. Keup (Ed.), *Origin and mechanisms of hallucinations* (pp. 103–113). New York: Plenum Press.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. *Psychological Review, 84,* 127–190.

Shimamura, A. P. (1986). Priming effects in amnesia: Evidence for a dissociable memory function. *Quarterly Journal of Experimental Psychology, 38A,* 619–644.

Shimamura, A. P. (1989). Disorders of memory: The cognitive science perspective. In F. Boller & J. Grafman (Eds.), *Handbook of neuropsychology* (Vol. 3, pp. 35–73). Amsterdam: Elsevier.

Shimamura, A. P., Janowsky, J. S., & Squire, L. R. (1990). Memory for the temporal order of events in patients with frontal lobe lesions and amnesic patients. *Neuropsychologia, 28,* 803–813.

Shimamura, A. P., Janowsky, J. S., & Squire, L. R. (1991). What is the role of frontal lobe damage in memory disorder? In H. S. Levin, H. M. Eisenberg, & A. L. Benton (Eds.), *Frontal lobe function and injury* (pp. 173–195). New York: Oxford University Press.

Shimamura, A. P., Jernigan, T. L., & Squire, L. R. (1988). Korsakoff's syndrome: Radiological (CT) findings and neuropsychological correlates. *Journal of Neuroscience, 8,* 4400–4410.

Shimamura, A. P., & Squire, L. R. (1987). A neuropsychological study of fact memory and source amnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 464–473.

Shimamura, A. P., & Squire, L. R. (1991). The relationship between fact and source memory: Findings from amnesic patients and normal subjects. *Psychobiology, 19,* 1–10.

Shoqeirat, M. A., & Mayes, A. R. (1991). Disproportionate incidental spatial-memory and recall deficits in amnesia. *Neuropsychologia, 29,* 749–769.

Slusher, M. P., & Anderson, C. A. (1987). When reality monitoring fails: The role of imagination in stereotype maintenance. *Journal of Personality and Social Psychology, 52,* 653–662.

Smith, S. M., Glenberg, A., & Bjork, R. A. (1978). Environmental context and human memory. *Memory & Cognition, 6,* 342–353.

Smith, M. C., & Milner, B. (1984). Differential effects of frontal-lobe lesions on cognitive estimation and spatial memory. *Neuropsychologia, 22,* 697–705.

Smith, M. C., & Milner, B. (1989). Right hippocampal impairment in the recall of spatial location: Encoding deficit or rapid forgetting? *Neuropsychologia, 27,* 71–81.

Spear, N. E., & Mueller, C. W. (1984). Consolidation as a function of retrieval. In H. Weingartner & E. S. Parker (Eds.), *Memory consolidation: Psychobiology of cognition* (pp. 111–147). Hillsdale, NJ: Erlbaum.

Squire, L. R. (1982). Comparisons between forms of amnesia: Some deficits are unique to Korsakoff's syndrome. *Journal of Experimental Psychology: Human Learning, Memory, and Cognition, 8,* 560–571.

Squire, L. R. (1987). *Memory and brain.* New York: Oxford University Press.

Squire, L. R., Amaral, D. G., & Press, G. A. (1990). Magnetic resonance imaging of the hippocampal formation and mammillary nuclei distinguish medial temporal lobe and diencephalic amnesia. *Journal of Neuroscience, 10,* 3106–3117.

Squire, L. R., Nadel, L., & Slater, P. C. (1981). Anterograde amnesia and memory for temporal order. *Neuropsychologia, 19,* 141–145.

Stern, L. D. (1981). A review of theories of human amnesia. *Memory & Cognition, 9,* 247–262.

Stuss, D. T., Alexander, M. P., Lieberman, A., & Levine, H. (1978). An extraordinary form of confabulation. *Neurology, 28,* 1166–1172.

Stuss, D. T., & Benson, D. F. (1986). *The frontal lobes.* New York: Raven Press.

Suengas, A. G., & Johnson, M. K. (1988). Qualitative effects of rehearsal on memories for perceived and imagined complex events. *Journal of Experimental Psychology: General, 117,* 377–389.

Talland, G. A. (1961). Confabulation in the Wernicke-Korsakoff syndrome. *Journal of Nervous and Mental Disease, 132,* 361–381.

Toth, J. P., & Hunt, R. R. (1990). Effect of generation on a word-identification task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16,* 993–1003.

Tousignant, J. P., Hall, D., & Loftus, E. F. (1986). Discrepancy detection and vulnerability to misleading postevent information. *Memory & Cognition, 14,* 329–338.

Tulving, E. (1962). Subjective organization in free recall of "unrelated" words. *Psychological Review, 69,* 344–354.

Tulving, E. (1983). *Elements of episodic memory.* Oxford, England: Clarendon Press.

Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science, 247,* 301–306.

Tversky, B., & Tuchin, M. (1989). A reconciliation of the evidence on eyewitness testimony: Comments on McCluskey and Zaragoza. *Journal of Experimental Psychology: General, 118,* 86–91.

Tzeng, O. J. L., Lee, A. T., & Wetzel, C. D. (1979). Temporal coding in verbal information processing. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 52–64.

Underwood, B. J. (1965). False recognition produced by implicit verbal responses. *Journal of Experimental Psychology, 70,* 122–129.

Underwood, B. J., & Malmi, R. A. (1978). An evaluation of measures used in studying temporal codes for words within a list. *Journal of Verbal Learning and Verbal Behavior, 17,* 279–293.

Voss, J. F., Vesonder, G. T., Post, T. A., & Ney, L. G. (1987). Was the item recalled and if so by whom? *Journal of Memory and Language, 26,* 466–479.

Warrington, E. K., & Weiskrantz, L. (1968). New method of testing long term retention with special references to amnesic patients. *Nature, 217,* 972–974.

Warrington, E. K., & Weiskrantz, L. (1970). Amnesic syndrome: Consolidation or retrieval? *Nature, 228,* 628–630.

Weiskrantz, L. (1986). *Blindsight.* Oxford, England: Clarendon Press.

Wells, G. L., & Loftus, E. F. (Eds.). (1984). *Eyewitness testimony: Psychological perspectives.* Cambridge, England: Cambridge University Press.

Whitlock, F. A. (1981). Some observations on the meaning of confabulation. *British Journal of Medicine Psychology, 54,* 213–218.

Whitty, C. W. M., & Lewin, W. (1957). Vivid day-dreaming: An unusual form of confusion following anterior cingulectomy. *Brain, 80,* 72–76.

Whitty, C. W. M., & Lewin, W. (1960). A Korsakoff syndrome in the post-cingulectomy confusional state. *Brain, 83,* 648–653.

Wickelgren, W. A. (1977). Speed–accuracy tradeoff and information processing dynamics. *Acta Psychologica, 41,* 67–85.

Winograd, E. (1968). List differentiation, recall, and category similarity. *Journal of Experimental Psychology, 78,* 510–515.

Woodruff, D. S. (1982). Advances in the psychophysiology of aging. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 29–53). New York: Plenum Press.

Yantis, S., & Johnson, D. N. (1990). Mechanisms of attentional priority. *Journal of Experimental Psychology: Human Perception and Peformance, 16,* 812–825.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35,* 151–175.

Zaragoza, M. S. (1991, June). *Source misattributions in eyewitness memory.* Paper presented at the 3rd Annual Convention of the American Psychological Society, Washington, DC.

Zaragoza, M. S., & Koshmider, J. W., III. (1989). Misled subjects may know more than their performance implies. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 246–255.

Zaragoza, M. S., & Lane, S. (1991, November). *The role of attentional resources in suggestibility and source monitoring.* Paper presented at the 32nd annual meeting of the Psychonomics Society, San Francisco.

Zaragoza, M. S., & Moore, K. (1990, November). *Source misattribution in eyewitness memory.* Paper presented at the 31st annual meeting of the Psychonomics Society, New Orleans, LA.

Zaragoza, M. S., & Muench, J. (1989, November). *Source confusion following exposure to misleading postevent information.* Paper presented at the 30th annual meeting of the Psychonomics Society, Atlanta, GA.

Zola-Morgan, S. M., & Squire, L. R. (1990). The primate hippocampal formation: Evidence for a time-limited role in memory storage. *Science, 250,* 288–290.

Received October 25, 1991
Revision received October 1, 1992
Accepted October 1, 1992 ■