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6

Identifying the Origin of Mental Experience

Marcia K. Johnson

The relationship among our perceptions, memories, knowledge, beliefs, and expectations on the one hand and reality on the other hand is one of the most intriguing questions in cognitive psychology (e.g., Johnson, 1988; Johnson & Raye, 1981; Johnson & Sherman, 1990). The evidence that this relationship is complex comes from a myriad of events in our everyday lives, from clinical, behavioral, and neurological observations, and is reflected in classic themes in art and literature. We sometimes forget whether we only thought about doing something or actually did it; we forget information was derived from fiction and recount it later as fact; authors unwittingly plagiarize; eyewitnesses disagree markedly on the details of a crime soon thereafter; couples disagree years later on the details of their first date; an interviewer remembers more weaknesses than strengths of a job candidate whose clothes, gender, or skin color are different from the norm for that job; an adult may remember childhood abuse that did not occur (e.g., see Johnson, Hashtroudi, & Lindsay, 1993; Loftus, 1993; Ross, in press; Wilson & Brekke, 1994).

Clinical observations of delusions and hallucinations associated with psychopathology provide striking examples of mental experiences divorced from reality that severely disrupt an individual's ability to function. As a result of certain types of organic brain disease, patients may deny one of their own limbs belongs to them or recount bizarre tales as events they actually experienced (Johnson, 1988, 1991a; Moscovitch, 1989; Stuss, Alexander, Lieberman, & Levine, 1978). Novels and movies sometimes compellingly depict a world in which dreams and reality are indistinguishable, or in which it is impossible to decide among various individuals' accounts of an event (the film *Rashomon*). The cumulative effect of all these examples might be that memory bears little relation to reality and is not to be trusted. However, this conclusion would reflect a naive constructivism that no more represents the nature of memory than does naive realism (Johnson, 1983). Errors of memory give clues, just as do errors of perception, about how memory works, including how it works when it is accurate.

My collaborators and I have argued that various errors and distortions of memory can be usefully understood within a framework for characterizing how memories are established, consolidated or maintained over time, accessed, and evaluated—the source-monitoring framework (e.g., Johnson, 1988; Johnson et al., 1993). This framework is an extension of the reality-monitoring model proposed by Johnson and Raye (1981) and draws on the multiple-entry, modular (MEM) cognitive architecture proposed by Johnson and colleagues (Johnson, 1983, 1991a, 1991b, 1992; Johnson & Chalfonte, 1994; Johnson & Hirst, 1993; Johnson & Multhaup, 1992).

According to this framework, the elements of perceptual experience (e.g., identified objects, their locations, colors, etc.) and reflective experience (e.g., ideas, plans) are encoded and bound together as a consequence of perception and reflection (e.g., Johnson, 1992). "Events" are constructed and remembered according to the background knowledge or schemas active at the time and the task agenda (e.g., Bartlett, 1932; Bransford & Johnson, 1973; Schank & Abelson, 1977). These constructed "accounts"—constructed products (Bransford & Johnson, 1973) or mental models (Johnson-Laird, 1983) of comprehension, interpretation, and problem solving—are subsequently rehearsed and narratized (Nelson, 1993; Spence, 1982). They are activated only if appropriate cues are available (e.g., McGeoch, 1932; Tulving & Thomson, 1973). Based on their phenomenal properties and relation to other memories, knowledge, and beliefs, they are evaluated (or monitored) and may be taken to be veridical memories according to criteria that change based on current conditions (e.g., the task, importance of errors, time, motivation, etc.; Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981).

Within this framework, errors and distortions of memory can arise (a) from factors operating as memory records are first established; (b) during an intervening interval; (c) at the time when memory records are subsequently accessed; and (d) when they are evaluated. The first three of these divisions are sometimes called *encoding*, *storage* (retention, consolidation), and *retrieval*; the last, *evaluation* (or monitoring), is often not explicitly considered at all. The next section describes the MEM cognitive architecture—a framework for characterizing cognitive processes underlying learning and memory. With this background in mind, the section returns to the issue of how individuals evaluate and discriminate the origin of information while remembering and considers conditions that affect source accuracy.

A MULTIPLE-ENTRY, MODULAR MEMORY SYSTEM

According to a multiple-entry, modular (MEM) memory system, memory is produced by perception and reflection; that is, it is the record of both perceptual and reflective activity (Johnson, 1983; see also Kolers & Roediger, 1984). MEM is an attempt to specify the types of perceptual and reflective component subprocesses needed for the wide range of memory phenomena illustrated in people's thought and behavior. The MEM architecture organizes these component processes into four functional subsystems, as shown in Fig. 6.1. The subsystems normally interact in any complex task but are proposed to be modular in the sense that they can engage in some functions without reference to other subsystems. The perceptual subsystems, P-1 and P-2, process and record information that is largely the consequence of perceptual processes. The reflective subsystems, R-1 and R-2, process and record information that is the consequence of internally generated processes, such as imaging and planning, that may occur independently of external stimuli. P-1 processes act on information that is typically not the focus of phenomenal awareness (e.g., cues that allow one to anticipate the trajectory of a moving object). P-2 processes act on a phenomenal world of objects and events. The reflective subsystems, R-1 and R-2, are generative; they allow one to manipulate information and memories (e.g., through imagining, retrieving, predicting, and comparing), and are driven by goals called *agendas*. The difference between R-1 and R-2 processes could be described as tactical versus strategic, or habitual versus deliberate; R-2 and P-2 typically operate on more complex data structures than do R-1 and P-1, respectively.

The P-1 subsystem is composed of processes of locating, resolving, tracking, and extracting. As examples, *locating* includes processes involved in visual capture of attention as well as auditory locating processes (e.g., Weiskrantz, 1986; Yantis & Johnson, 1990); *resolving* includes processes for defining basic perceptual units (e.g., edges [Marr, 1982], geons [Biederman, 1987], or deriving structural descriptions [Riddoch & Humphreys, 1987; Schacter, 1992]); *tracking* includes processes involved in following a moving stimulus (e.g., with stimulus-guided eye movements; Kowler & Martins, 1982); and *extracting* includes processes involved in extracting invariants, such as texture gradients and flow patterns (Gibson, 1950).

The P-2 subsystem includes the component processes of placing, identifying, examining, and structuring. As examples, *placing* includes processes that represent the relation of objects to each other (Mishkin, Ungerleider, & Macko, 1983), *identifying* includes processes that assign stimuli to meaningful categories (e.g., Biederman, 1987), *examining* in-

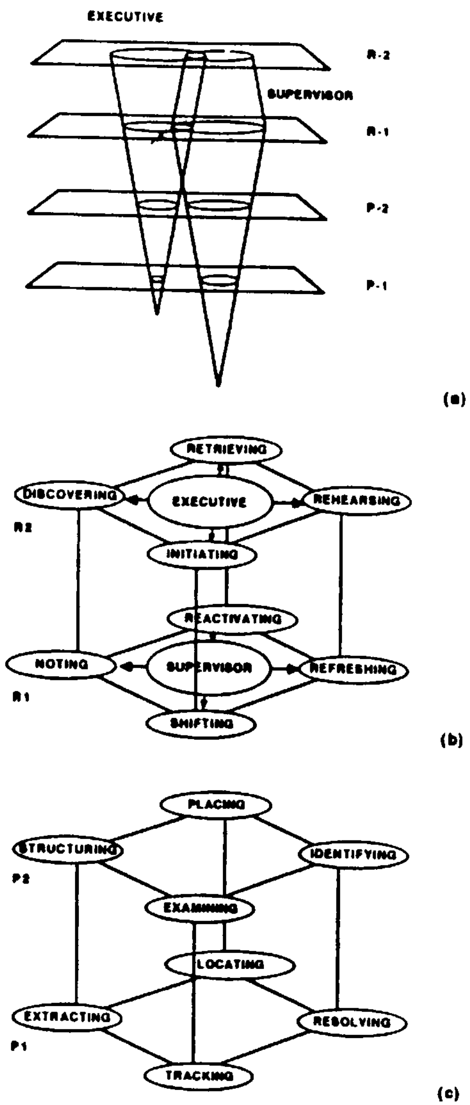

FIG. 6.1

cludes processes (often driven by learned perceptual schemes) that guide the order of perceptual inspection of a stimulus array (e.g., Hochberg, 1970), and *structuring* includes processes that parse temporally extended stimuli into "syntactic" units (e.g., the syntax of one's language, patterns of familiar movements, or melodic structures from notes; Fodor, Bever, & Garrett, 1974; Krumhansl, 1990). As is apparent from these examples, perceptual component processes in MEM cumulate the products of prior experience. Thus, perception, especially P-2 processing, includes meaningful responses to meaningful stimuli.

Reflection allows one to go beyond the immediate consequences (both direct and associative) of stimulus-evoked activation. Whereas perception is exogenously generated cognition, reflection is endogenously generated cognition. Reflective processes are what give people the sense that they are taking an active role in their thought and behavior. This idea of active control is often assigned to a central executive in cognitive theories (e.g., Baddeley, 1992). In MEM, there is no central executive. Rather, reflection is guided by agendas, any one of which serves as a virtual executive while it is active (cf. Dennett, 1991). For convenience of reference, in Fig. 6.1, the collection of possible R-1 agendas is denoted *supervisor* and the collection of possible R-2 agendas is denoted *executive*. It is important for agendas to be represented separately in the two reflective subsystems because their interaction provides a mechanism for (a) control and monitoring of complex thought and action, (b) self-observation and self-control, and (c) certain forms of consciousness (see Johnson & Reeder, in press, for a more extended discussion of MEM and consciousness). Agendas (both well learned and ad hoc) recruit various reflective and perceptual processes in the service of specific goals and motives.

The component processes of R-1 are *refreshing, reactivating, shifting,* and *noting*. *Refreshing* prolongs activation of already active perceptual and reflective representations. For example, refreshing of targets likely occurs when the signal indicates which subset of items in a complex display are to be reported (Sperling, 1960). *Reactivating* brings inactive

FIG. 6.1. (a) A multiple-entry, modular (MEM) memory system, consisting of two reflective subsystems, R-1 and R-2, and two perceptual subsystems, P-1 and P-2. Reflective and perceptual subsystems can interact through control and monitoring processes (supervisor and executive processes of R-1 and R-2, respectively), which have relatively greater access to and control over reflective than perceptual subsystems. (b) Component subprocesses of R-1 and R-2. (c) Component subprocesses of P-1 and P-2. From Johnson, M. K., in *Mental Imagery* (p. 4) by R. G. Kunzendorf, 1991b, New York: Plenum. Copyright 1991 by Plenum. Adapted by permission.

representations back into an active state. For example, reactivating occurs when a specific task agenda (e.g., the goal to organize and learn a list) is combined with a current cue to activate relevant prior information (e.g., seeing *dog* in a list reminds one that *cat* was previously on the list). *Shifting* involves changing a current activation pattern in combination with a task agenda or cues (e.g., shifting from thinking of a dog's tail to thinking of a dog's ears in an imagery task; Kosslyn, 1980). *Noting* involves identifying relations within current activation patterns (e.g., noting that cats and dogs are both animals, or noting that a dog's ears are pointed).

The component processes of R-2 are *rehearsing, retrieving, initiating*, and *discovering*. These are analogous to R-1 processes, but are more extended and sometimes require iterations that are initiated or controlled by endogenously generated cues. For example, *rehearsing* requires recycling back to representations to keep them active. Hence, rehearsing requires that some representation be kept active of the number of items to be rehearsed, or the interval since a particular item was last rehearsed (e.g., Baddeley, 1986). *Retrieving* requires the self-generation of cues when the task agenda and immediately available cues are not sufficient to activate the desired representation (e.g., Reiser, 1986). For example, if the task agenda to recall List A and the experimenter-provided cue *vegetable* are not enough to produce reactivation of a target item, one might cue oneself with questions: Were there any green vegetables on the list? Any unusual vegetables? Similarly, *initiating* involves shifts in how active information is considered. These shifts are generated by cues that were endogenously generated to solve a task problem. For example, in the tumor-radiation problem (Duncker, 1945; Gick & Holyoak, 1980), the subject might initiate a shift from thinking about how to destroy the tumor to how not to damage the patient's flesh by listing all the potential problems in the situation. *Discovering* involves finding relations that are not immediately present in a given activation pattern, but that require some mediating idea that is self-generated, perhaps by some algorithm or strategy (Gentner, 1988). For example, in looking for a way to relate two stories, one might try to characterize the theme of each at the most general level and then look for matching ideas.

The activity of any of these component processes generates changes in memory (i.e., records or representations). Subsequent activities directed at these representations (reactivating, noting, etc.) also generate changes in memory. Changes in memory can be expressed in behavior (e.g., seeing something more easily under degraded conditions that was seen before; Jacoby & Dallas, 1981) or phenomenal experiences, such as remembering an autobiographical event (e.g., Johnson, Foley, Suengas, & Raye, 1988) or knowing a fact (Collins & Quillian, 1969). For example, memory representations in P-1 and P-2, including representation of concepts representing the identity of objects, are likely responsible for many cases of priming (e.g., DeSchepper & Treisman, 1996; Dunn & Kirsner, 1988; Jacoby & Dallas, 1981; Tulving & Schacter, 1990) and perceptual learning (Cohen & Squire, 1980; Nissen & Bullemer, 1987). Face recognition may be based largely on memory representations in P-2, but is sometimes augmented with memory of cognitive operations provided by R-1 or R-2 (e.g., noting a face looks like Uncle Bob). Recall of categorized lists may be largely based on representations generated by organizational activity of R-1, and recall of complex stories is more likely based on representations generated by R-2 activity. Of course, processes from all subsystems may be operating in any particular situation.

The term *representation* does not imply that a memory consists of information represented by a single node or by a single, unified trace. It is assumed in MEM that memories are distributed among the processing circuits that were in effect when they were established. Furthermore, some features may be recorded, but not bound together, or some bound features may fail to be activated under some task conditions that could be activated under others. Likewise, features may be activated in new combinations that would give rise to source errors. Evidence for these assumptions is considered in later sections of this chapter.

Various breakdowns in cognition and memory occur when any one or any combination of these component processes are disrupted through distraction, stress, drugs, psychopathology, or brain damage (e.g., Johnson, 1983; Johnson & Hirst, 1993). For example, perceptual phenomena such as blindsight or agnosias could occur from selective disruptions in perceptual processes, or in the interactions between perceptual and reflective processes (Johnson & Reeder, in press). Deficits in complex learning and problem solving might occur if R-2 processes were disrupted (Johnson & Hirst, 1993). Disruptions in consciousness would arise from disruptions in transactions between subsystems (Johnson & Reeder, in press). This chapter is particularly concerned with how breakdowns might occur in an individual's ability to identify the origin of memories.

The component processes of MEM are described in terms of a mid-level vocabulary. The proposed processes are polymorphic, each representing a class of similar operations performed on different data types (Johnson & Hirst, 1993; Johnson & Reeder, in press). Thus, for example, the same term is applied to similar operations that occur in different sensory modalities. It is proposed here that the component processes of MEM represent different transactions among brain regions or circuits of activity (Johnson, 1992; Johnson & Chalfonte, 1994). Because these component processes are interactions among regions, they can be disrupted in more than one way. Because different circuits are dedicated to different versions of a process (e.g., refreshing auditory/verbal information would involve a different circuit than refreshing visual/pictorial information), considerable specificity of disruption from highly localized brain lesions would be expected. Some of the specific brain regions that are implicated in MEM's processing circuits are considered after reviewing behavioral evidence regarding source-monitoring processes.

SOURCE MONITORING

Our investigations of source monitoring and reality monitoring are directed at clarifying underlying mechanisms that allow people, despite the potential for confusion illustrated in the introductory paragraph, to manage to operate in the real world rather well, both as individuals and in a sociocultural context (Johnson, in press; Johnson & Reeder, in press; Johnson et al., 1993). When we began this research in the 1970s (Johnson, 1977; Johnson, Taylor, & Raye, 1977), we confronted two critical problems that affected the approach. The first was that perception and reflection (inference, imagination, etc.) are normally so intertwined it is hard to say where one ends and the other begins (e.g., Bartlett, 1932; Bransford & Johnson, 1973). How, then, could the memory representations generated by perception and reflection be compared and the mechanisms that are important for discriminating between them investigated? The second problem was that memory is both constructive (at encoding) and reconstructive (at recall). How could one know, in any particular situation, whether source misattributions reflected confusions of the records of prior constructions with records of prior perceptions, or whether source misattributions reflected confusions of new constructions with records of prior perceptions? Of course, based on an understanding of memory as both constructive and reconstructive, both types of source confusions were expected to occur under appropriate circumstances, but it was important to be able to say which type the subjects were producing. This led to the development of experimental paradigms that addressed both these problems by starting with clear, rather than ambiguous, events occurring at specified points in time.

Although perception and reflection are intertwined, the relative proportions of each, across situations, vary along a continuum. Thus, we started with the two ends of the continuum of information that people acquire: information that is derived primarily from external events (e.g., pictures or words we presented) and information that is the result of internally generated cognitive operations (e.g., images or words the

subjects generated). If we could clarify the conditions under which (and thus the mechanisms by which) these two are distinguished in memory, we would be able to extend the analysis to understanding the more difficult to investigate, intermediate cases, in which the representation of a single event consists of a complex mixture of perception and imagination. Similarly, if we controlled when the perceived and imagined events took place, rather than leaving the imagination up to the spontaneous mental activity of the subject, as was done in most earlier studies (e.g., Deese, 1959; Johnson, Bransford, & Solomon, 1973), we would know that subjects were confusing past imaginations with past perceptions.

The processes of distinguishing externally and internally generated information is referred to as *reality monitoring*. However, reality monitoring is just one subset of the larger problem of identifying the origin and veridicality of perceptions, memories, knowledge, and beliefs, which is called *source monitoring* (Johnson, 1988). In addition to discriminating between information from primarily internal versus external sources, source monitoring includes distinguishing among different types of internally generated information (e.g., what one thought from what one said), distinguishing among different external sources (e.g., what one heard on the news from what one heard a colleague speculate at the office), as well as identifying other contextual attributes of an event (e.g., where and when it occurred, its color, etc.).[1] Because the mechanisms of reality monitoring should be clearer if compared to other types of source monitoring, such comparisons have been an ongoing part of the strategy for exploring the mechanisms by which memories become distorted (e.g., Foley, Johnson, & Raye, 1983; Raye & Johnson, 1980; see also Johnson, 1988) and, by extension, the mechanisms by which knowledge and beliefs become distorted (Johnson, 1988).

Our approach to understanding source monitoring is based on two propositions. First, mental experiences from different sources differ on average in their phenomenal qualities. Second, distinguishing between or among sources is potentially a two-factor attributional process: The first typically is a quick decision based on phenomenal qualities of a

[1]The term *source* is used as a general way of referring to those aspects of experience that have variously been called origin, circumstances, or context in addition to source (e.g., Spencer & Raz, 1995). Source information, like context, is generally distinguished from "content" or "item" information. Thus, if you see a series of words, the semantic meaning of each is presumed to be the content, and aspects—such as color, typeface, location, voice, general environmental details, mood, state of mind, and so forth—are presumed to constitute the context or source information. To some extent, the distinction between content and context (source) is artificial because it should depend on the goals of the subject. However, it has heuristic value, hence it is used here.

mental experience, and the second usually is a slower process that was initially called *extended reasoning*. Extended reasoning included retrieval processes, judgments based on other supporting or disconfirming knowledge or memories, assumptions about how memory works, and so forth. These two types of processes are now thought of as governed by R-1 and R-2 agendas, respectively, and thus they are referred to as *heuristic* (or R-1) and *strategic* (or R-2), following Chaiken's (Chaiken, Lieberman, & Eagly, 1989) terminology for processes involved in evaluating persuasive messages (Johnson et al., 1993).

Qualitative Characteristics of Memories and Judgment Processes

Among the most important attributes of memories that make them "episodic" or identify their origin are perceptual information (e.g., sound, color), contextual information (spatial and temporal), information about cognitive operations (imagining, retrieving, inferring), semantic information, and affective information. The heuristic decision processes used to distinguish source capitalize on average differences in these attributes among memories from various sources. For example, compared with internally generated memories, externally generated memories typically have more sensory/perceptual and spatial/temporal information, and their semantic information tends to be more detailed and less abstract. Also, memory records information not only about the consequence of mental activity, but about the mental activities as well; this record of cognitive operations tends to be more available for imaginal than for perceptual processes (i.e., perception is typically somewhat more automatic than imaginal processes). If two classes of memories (e.g., internally and externally derived) tend to differ in these ways, even if their distributions overlap on some or all qualities, they generally could be discriminated, although errors would sometimes occur. Errors should be related to predictable deviations from the average distributions (e.g., people who are good imagers should have more difficulty than poor imagers distinguishing whether they perceived or imagined a picture of an object, and they do; Johnson, Raye, Wang, & Taylor, 1979).

Many source-monitoring decisions are made rapidly or heuristically on the basis of qualitative characteristics of activated memories. For example, one might attribute a memory to perception based on the amount or vividness of perceptual detail in the memory. Or one might attribute a memory of a statement to the newspaper because the memory includes the information that it was on the front page. In these cases, there may be little awareness of the source-judgment process, but a judgment process has, nevertheless, occurred. At other times, a more systematic or

deliberative decision may be made requiring the retrieval of additional information or an inferential, strategic reasoning process. For example, trying to remember who proposed an idea in a meeting might include retrieving other information about what each person is currently working on, and therefore who was the more likely candidate. Of course, any additional information that is retrieved is potentially subjected to a heuristic check, and can become the cue for further strategic retrieval.

Both heuristic and strategic processes require setting criteria for making a judgment and procedures for comparing activated information to the criteria. For example, if the amount of contextual detail exceeds X, the heuristic evaluation is that the event was probably perceived. Similarly, some threshold, Y, for the degree of consistency between the target memory and additionally retrieved knowledge or information must be exceeded for a strategic evaluation that an event was perceived. Which judgment processes are used in any given situation should be affected by the relative distributions of memory characteristics and higher level agendas that might change the need (threshold) to be accurate (e.g., the cost of a mistake), or might change the relative weights given to different memory characteristics (e.g., affective information and perceptual information). For example, criteria are likely to be more lax in a casual conversation with a friend (e.g., recalling the source of gossip) than in a professional meeting (e.g., recalling the source of scientific data).

Errors and Deficits in Source Monitoring

Given this basic characterization of source monitoring, it is clear that errors may be introduced in a number of specific ways.

Factors Operating When Target Memories Are Encoded

Feature Binding. Accuracy of source monitoring varies as a function of the quality of the underlying information in memory. That is, a complex event memory depends on the binding of various features of experience together into a cohesive representation, such that when one aspect is activated other aspects are as well (Johnson, 1992). Incidental binding of some features occurs as a consequence of perceptual processing (e.g., item and location; Hasher & Zacks, 1979), but such incidental binding is less likely to support recall than recognition (Chalfonte & Johnson, 1995). The binding of other features (e.g., color and item) appears to profit from intentional processing even for recognition (Chalfonte & Johnson, 1996). Color and location are the types of attributes necessary for identifying the origin of item information.

What are the processes that produce binding among the features of memories? According to MEM, some binding among features may occur as a consequence of coactivation during perceptual processing alone, but binding is affected by reflective processes as well (Johnson, 1992; Johnson & Chalfonte, 1994). For example, feature binding between a person, Bill, and the color of his shirt is more likely to occur if the idea or image of Bill and his shirt color are *refreshed* or *reactivated* together than if they are not. Similarly, binding between Bill's voice and the semantic content of what he says is more likely to occur if those two features (voice and content) are *refreshed* or *reactivated* together. Binding is also augmented by more organizational reflective processes, such as *noting* that Bill's shirt and pants do not match. Consistent with this, when subjects are distracted during an initial experience—by being required to do a secondary task that interferes with their ability to engage in reflective operations for processing the target material—their later source accuracy is reduced (Craik, 1983; Craik & Byrd, 1982; Jacoby, Woloshyn, & Kelley, 1989).

Among the factors that can affect the nature and quality of feature binding, perhaps one of the most intriguing is emotion. Under some circumstances, emotion can disrupt the encoding of perceptual information and/or the binding of perceptual information to content (Hashtroudi, Johnson, Vnek, & Ferguson, 1994; Suengas & Johnson, 1988). For example, in a recent series of studies (Johnson, Nolde, & De Leonardis, 1996, subjects listened to a tape of two people speaking. The speakers made various statements that varied in emotion (as rated by other subjects): Congress should pass a law prohibiting prayer in the classroom; I support the death penalty; I have an intense fear of flying; There is too much violence on TV; Interracial relationships do not bother me; I can speak two languages fluently; The Sistine Chapel is in Rome. In the actual experiment, the subjects' focus was varied while they were listening to the speakers. In one condition, subjects were told the investigators were interested in people's ability to perceive other people's emotions; in another condition, subjects were told the investigators were interested in the degree to which they agreed with what was being said. After a 10-minute retention interval, subjects took a surprise memory test. The results were quite clear. Relative to focusing on how the speaker felt, when subjects focused on how they felt, they had higher old–new recognition, but lower source-accuracy scores. Also, in the self-focus condition, there tended to be a negative correlation between rated emotion of the statements and source accuracy. Subjects were less accurate on the more emotion-evoking statements. These findings suggest that attention (i.e., *refreshing, retrieving, noting,* etc.) to one's own emotional reactions may occur at the expense of attention (i.e., *refreshing, retrieving, noting,* etc.) to other aspects of events that are critical for later identifying the origin of remembered information.

The Discriminability of Sources. Even if various memory attributes are bound into complex event memories, the likelihood of later misattributing memories from one source to another is related to the similarity of the memories from the two sources. That is, the nature of the encoding operations (perceptual and reflective cognitive operations engaged, semantic schemas recruited, etc.) determines the potential for later discriminability of memories from various sources. For example, Lindsay, Johnson, and Kwon (1991) showed that the more semantically similar the topics addressed by two speakers were, the more likely subjects were to later confuse what one speaker said with what another said.

Perceptual similarity is critical as well. Ferguson, Hashtroudi, and Johnson (1992) showed that the more similar two speakers were, the more likely subjects were to confuse what each had said. Johnson et al. (1979) varied the number of times subjects saw various pictures and the number of times they imagined each of the pictures. Subsequently, subjects were asked to indicate how many times they had seen a picture. Frequency judgments of good imagers were more influenced by the number of times they had imagined a picture than were frequency judgments of poor imagers. This outcome is consistent with the idea that the degree of perceptual information in memories for perceived and imagined objects was more similar for the good imagers than for the poor imagers (see also Dobson & Markham, 1993; Markham & Hynes, 1993).

Likewise, the type of cognitive operations engaged can create records that are more or less discriminable for events of various classes. For example, Durso and Johnson's (1980) subjects saw some concepts represented as pictures and some as words. During presentation of the concepts, some subjects rated the time it would take for an artist to draw the pictures or to draw pictures the subjects imagined for the word items. Other subjects gave a function for each item (e.g., knife–cut). Durso and Johnson suggested that the subjects in the function task would be likely to spontaneously generate images of the items referred to by words as they answered the function questions. These spontaneously generated images would have less salient cognitive operations than the intentionally constructed images of subjects in the artist time judgment task. Because the difference between the cognitive operations information in the records of perceived and imagined events should be less clear for the function than the artist time group, the function group should later be more likely to claim they had seen pictures of items presented as words. The results were consistent with this prediction. Subjects were three times as likely to falsely claim they had seen pictures of word items in the function than in the artist time judgment condition (see also Rabinowitz, 1989; Finke, Johnson, & Shyi, 1988). Similarly, Dodson and Johnson (1996; Experiment 2) showed that the more similar the cognitive operations performed on two classes of items were, the more likely they were to be later confused (see also Johnson, De Leonardis, Hashtroudi, & Ferguson, 1995; Lindsay & Johnson, 1991).

Factors Operating Before or After Target Events

Not only do the component cognitive processes engaged initially affect source monitoring, but what happens before and after an event can have a marked effect on the accuracy of one's memory for that event. For example, reactivating content information can increase the chances that it is remembered later (Hogan & Kintsch, 1971; Landauer & Bjork, 1978). There is not direct evidence regarding reactivation and memory for source, and such studies are very much needed. However, there is some evidence from studies of subjects' ratings of the phenomenal characteristics of their memories. Suengas and Johnson (1988) had subjects participate in or imagine participating in various simulated autobiographical events, such as wrapping a package, meeting someone, or having coffee and cookies. Subjects actually engaged in some activities or were asked to imagine engaging in others, guided by a script. Later, subjects filled out a memory characteristics questionnaire (MCQ) designed to assess various qualitative characteristics of their memories (e.g., How well do you remember the spatial arrangement of objects? How well do you remember how you felt at the time?). Generally, the ratings on characteristics such as visual clarity and contextual detail are higher for perceived than for imagined events (see also Hashtroudi, Johnson, & Chrosniak, 1990). Suengas and Johnson also investigated the impact on MCQ ratings of having subjects think about events after they happened. They found that, if people do not think about events, visual details and other characteristics tend to be less accessible over time. If people do think about events, visual and other details tend to be maintained. They also found that the effect of thinking about imagined events was about the same as thinking about perceived events. This finding suggests that if people selectively reactivate imaginations, memories for those imaginations could begin to rival in vividness perceived events from the same time frame. Thus, depending on what is reactivated, thinking about events could preserve: (a) veridical memories of actual events, (b) the vividness of memories of imagined events, or (c) the vividness of the imagined embellishments of either actual or imagined events. That is, depending on what representations cognitive operations such as *reactivating* and *retrieving* are applied to, they can act to consolidate and maintain veridical or nonveridical memories, knowledge, and beliefs.

In addition to considering the kinds of rumination and rehearsal (thinking and talking) individuals do about an event after the fact, along with any associated imagining, it is also important to consider the other types of events that might intervene between the time of the initial event and its attempted recall. Has the individual heard or read other accounts? Seen pictures? Seen related movies or read related novels? All of these intervening events (and, in fact, prior events as well) are potential sources of memories that can become candidates for confusion with the original event. Particularly intriguing is the status of information generated in dreams. Although most dreams seem extremely short-lived, evidence suggests that the information persists longer than one might expect (Johnson, Kahan, & Raye, 1984), and thus one's own dreams provide elements that may subsequently be cued and confused with actual events.

Elements or features from prior or subsequent events can recombine with elements of a target event to create false memories. For example, Henkel and Franklin (in press) had subjects see some pictures and imagine others. Subjects were more likely to later claim they had seen an imagined item (e.g., a lollipop) if they had seen a presented picture that shared some features with the imagined item (e.g., a magnifying glass). Thus, attributes of perceptually experienced events can increase the chances of believing that one has perceived other events that one has only imagined. A subsequent study (Henkel & Franklin, 1995) showed an intriguing cross-modal effect. Subjects who heard a dog barking and, at another point, imagined seeing a dog were more likely later to believe they had actually seen a dog than were subjects who had twice imagined seeing a dog. More generally, source confusions as a consequence of recombinations of perceived elements of stimuli can occur (Reinitz, Lammers, & Cochran, 1992). That is, subjects may recognize various elements, but not accurately remember which events were the source of the elements (i.e., to which other elements these were bound), and thus falsely attribute the recombined elements to a single event.

Factors Operating During the Access and Monitoring of Memories

Finally, distortions in memory can be introduced by factors occurring at the time an individual uses or draws on memory records. First, consider that accurate source attribution depends on the successful revival of information that could specify source. What would disrupt revival of such information? Any mismatch between encoding and testing conditions reduces the chances for successful revival of potentially useful source-specifying information (e.g., Tulving & Thomson, 1973). If cue conditions are not sufficient to revive perceptual, contextual, affective, semantic, or cognitive operations information that can help specify the origin of a memory or belief, then clearly source monitoring will suffer. A mismatch could happen because external cues are not appropriate (e.g., a change in environment; Godden & Baddeley, 1975), or because internal cues, such as mood, are not appropriate (Eich & Metcalfe, 1989).

Even if appropriate cues are present, certain conditions may interfere with source monitoring. Such interference can come from distraction, stress, depression, and drug-induced effects. Consider the case where an individual is asked to monitor the origin of information while performing another, unrelated task (Jacoby et al., 1989; Zaragoza & Lane, 1994). A secondary task may induce source confusions in a number of ways: It may interfere with (a) the activation of attribute information, (b) *noting* the relevance of attribute information to a source-monitoring agenda, or (c) the *retrieval* of additional confirming or disconfirming evidence. If the revived information is not specific enough, if the individual's agenda does not call for explicit source monitoring, or if the secondary task is sufficiently demanding, people may be induced to make source judgments on the basis of familiarity (e.g., Jacoby et al., 1989). As is discussed next, all source attributions (even those based on familiarity; see Dodson & Johnson, 1996) occur in the context of agenda-controlled criteria.

Because source judgments are attributions about the origins of memories, knowledge, and beliefs, they are always made in the context of evaluative criteria. Is this evidence sufficient to conclude that this mental experience arose because of a specific past experience (attributing a memory to a past event)? Is this evidence sufficient to conclude that this knowledge has a basis in fact (e.g., read in a reputable source, based on direct experience, etc.)? Is this evidence sufficient to conclude that this belief is reasonable given what I know or remember? Thus, there is a hierarchy of reality monitoring, whereby truth at the level of belief depends on veridicality at the level of knowledge, which depends on veridicality at the level of episodic events. That is, reasonable beliefs depend on accurate knowledge, which depends on veridical event memories. The criteria applied at any of these levels are not fixed, but change with circumstances. The level of evidence one feels one needs in order to say they remember, know, or believe depends on many factors, including the active agenda, social context, cost of mistakes, and amount of distraction.

Several experiments demonstrate the effects of shifts in criteria in source monitoring, depending on test conditions. For example, Dodson and Johnson (1993) had subjects look at a series of pictures of unrelated complex scenes. Subjects then read short passages describing scenes, some of which had been previously shown as pictures, but most of which had not. Later, subjects were given verbal cues that referred to pictured and/or read scenes and new scenes. Subjects were asked to indicate which scenes had been shown as pictures and which had not, and then to indicate which had been described in a passage and which had not. Replicating a result previously reported by Intraub and Hoffman (1992), Dodson and Johnson found a high rate of source errors: Subjects frequently claimed to have seen pictures for scenes that had only been described. Like Intraub and Hoffman, Dodson and Johnson attributed these false recognitions to reality-monitoring failures. Presumably, subjects imagined scenes while they read about them and later mistook their imagined scenes for pictured scenes.

However, in a second condition, Dodson and Johnson asked subjects to indicate for each test item whether they had seen it as a picture, read it as a description, both seen and read it, or neither. With this relatively subtle change in test instructions, the false recognitions were greatly reduced. The second type of test apparently tightened the subjects' criteria for attributing a memory to a perceived picture. When subjects explicitly considered whether a memory was derived from a picture or narrative, they evidently looked more carefully at the level of perceptual detail in the memory, or looked more carefully for evidence of the types of cognitive operations that generated the memory (e.g., imagining, reading). Any increase in the amount of perceptual detail required as evidence that a remembered item was actually perceived would decrease the number of false recognitions of imagined scenes. Similar reductions of source confusion with a change in test conditions have been reported in eyewitness testimony (Lindsay & Johnson, 1989; Zaragoza & Lane, 1994) and false fame (Multhaup, 1995) paradigms (see also Hasher & Griffin, 1978; Raye, Johnson, & Taylor, 1980).

Some errors in reality monitoring are introduced at the time of remembering not because of disrupted retrieval or inappropriate criteria, but because the individual has a poor knowledge base. For example, certain memories might be quite vivid, say the memory of a spaceship that occurred in a dream. Before a child has acquired a working knowledge about dreams, it might be extremely difficult not to attribute such a recollection to memory for a real event.

Individuals do not have to forget the actual source to misattribute information to another source. For example, in an eyewitness study, subjects do not have to forget that they read certain information to mistakenly believe that they also saw it as part of the original event (Dodson & Johnson, 1993; Lindsay & Johnson, 1989; Zaragoza & Lane, 1994). They can believe that they both saw it and read about it later (see also Fiedler et al., 1995). In fact, there may be certain circumstances in which one's confidence that they saw something is actually increased by their recollection that they "also" heard it described by someone else.

As discussed earlier, source confusions often arise because information is misattributed to perception that was filled in by inferences, schemas, or knowledge-driven constructive processes engaged as events are processed, comprehended, and responded to in everyday activities and similarly engaged reconstructively as events are subsequently remembered. Typically these generations are assumed or believed to be true at the time they occur (regardless of whether they are in fact). Resulting reality-monitoring errors may often escape people's awareness because construction and reconstruction is a ubiquitous aspect of perceiving, comprehending, and remembering. However, it is important to emphasize that people may later attribute to reality or be influenced by information that they initially knew was imagined, fictional, or dubious (Durso & Johnson, 1980; Finke et al., 1988). For example, Fiedler et al. (1995) found that subjects might answer a question about a previously seen video correctly and then later falsely recognize information that had been presupposed by the same misleading question they had answered correctly. Subjects can know they are reading fiction and later have their attitudes influenced by what they read (Gerrig & Prentice, 1991). They can also know that an idea came from their own dream initially, but later claim they heard it from someone else (Johnson et al., 1984), or be told information is false and yet later be influenced by it (Gilbert, Tafarodi, & Malone, 1993). That is, what people remember, know, or believe may incorporate information from waking imagination, dreams, conversations with known liars, novels, TV programs, movies, and so forth—from sources that people understood at the time did not represent a true state of affairs.

Source accuracy is also affected by one's motivation to be accurate, including one's assessment of the effort involved and the costs of mistakes. For example, memories and beliefs that enhance self-esteem are often examined less carefully than those that do not. In short, reality monitoring can be thought of as a case in which one is persuading oneself, hence the factors that operate in any persuasion situation should operate in reality monitoring (cf. Eagly & Chaiken, 1993).

Finally, at all stages, source memory is affected by the social context. At encoding, social dynamics may determine how events are interpreted to begin with. Other people affect which cognitive agendas are operating, which in turn determine which aspects of experience are refreshed, noted, and bound into cohesive or complex event representations. During any retention interval, social interaction is one of the most important contexts for rehearsal and rumination about past events (e.g., Nelson, 1993), and one of the most likely sources of information that potentially might be confused with information derived from the original event. To a great extent, the interest and social support of others determines which memories, knowledge, and beliefs are worth preserving and which are likely to be embellished. Social factors operate during remembering. For example, remembered social interactions can be taken as evidence for the veridicality of one's own memories (e.g., Johnson et al., 1988). Remembering often takes place interactively in discussions where people come to agree on what happened (Edwards & Middleton, 1986a, 1986b; Edwards, Potter, & Middleton, 1992). Perhaps most important, the social context helps establish the evidence criteria used (Is this a casual conversation or a discussion with important consequences?), and provides support for or challenges to what one has remembered, asserted as fact, or offered as reasonable belief. Social processes and institutional, cultural mechanisms (investigative news reporting, courts, educational practices) can either support or work against accurate reality monitoring (Johnson, in press).

Summary of the Source-Monitoring Framework

Three broad classes of source monitoring have been distinguished (Johnson, 1988; Johnson & Sherman, 1990): Reality-testing processes evaluate the origin of current perceptions; reality-monitoring processes evaluate the origin of memories, knowledge, and beliefs; and reality-checking processes evaluate the reasonableness or probability of anticipated or imagined futures. All are carried out by R-1, heuristic judgment processes applied to the evidence at hand (e.g., vividness of the mental experience, the ease with which a future can be imagined) and R-2, systematic processes that search out other relevant evidence and evaluate it (e.g., noting a tail on an object to confirm it is a dog; retrieving one's qualifications for a hoped-for job). Everyone experiences errors in reality testing, monitoring, and checking, but severe, chronic breakdowns produce hallucinations and delusions that can profoundly disrupt an individual's ability to function.

Based on the source-monitoring framework, the following are some of the factors that can lead to false memories, and false beliefs in general, and that can produce hallucinations, confabulations, and delusions, especially if several factors operate in combination (Johnson, 1988, 1991a, 1991b): (a) Interpretive, inferential, and constructive processes in understanding add information based on prior knowledge. Furthermore, the schemas used may be partially or wholly constructed from self-generated and not necessarily veridical information. (b) Complex perceptions, event memories, knowledge, or beliefs require the binding together of various features of experience; inappropriate agendas, stress, distraction, drugs, and brain damage can disrupt these binding processes. (c) Because perceptual information is an especially important cue in reality monitoring, the perceptual characteristics of phenomenal experience (including imagined events or real anomolous perceptual experiences, such as seeing floaters) tend to compel belief regardless of their origin. (d) Rehearsal (rumination, talking about) inflates estimates of the frequency of events, increases vividness and elaboration of imagined information, and embeds imagined events and ideas in a network of other events, beliefs, or emotions. This vividness and embeddedness may be taken as evidence that the memory or belief is veridical. (e) Anything that decreases reflective control (e.g., dreams, hypnosis) should make events more likely to be taken for real or beliefs more compelling or persuasive. This occurs either because current perceptual experience (or ideas) or activated records of perceptual information (or ideas) dominate phenomenal experience when reflective activity is "turned off," or because the experience (or memory) of reflective control is a primary cue that information is originating from within (the "unbidden" seems to come from without). (f) Inappropriate criteria, such as applying a low standard of evidence for an idea or memory one finds comforting or that fits with an active agenda or a favored hypothesis, induces reality-monitoring failures. (g) Individual differences account for some of the variability in source monitoring. For example, individuals differ in habitual attitudes, such as their modes of dealing with ambiguity or how willing they are to trust first impressions. Johnson (1991b) further suggested there may be individuals who rely primarily on R-1 processes (experiential types) and others who rely primarily on R-2 processes (instrumental types); they might show different patterns of reality-monitoring failures. For example, experiential individuals may be more persuaded by perceptual detail (use R-1 heuristics), whereas instrumental individuals may be more persuaded by whether something seems plausible (use R-2 strategies). Each type of decision rule, if unchecked by the other, can lead to error. (h) Reality monitoring is a skill. Adopting a critical attitude toward one's memories and beliefs may not be spontaneous, but may require some education and practice (e.g., see also Gilbert, 1991). (i) Accurate reality monitoring depends, to some extent, on the availability of alternative interpretations for mental experiences, especially feelings. An individual who thinks that some physical symptoms could arise from a hormone imbalance will develop a different set of hypotheses to test than an individual who only considers an invasion of his or her body by aliens. Social and cultural contexts are especially important, and can either support false beliefs or help correct them. In short, false

memories and beliefs that are severe enough to be called confabulations and delusions can result from intense and unusual perceptual experiences, inappropriate weighting of various qualities of mental experience, selective interpretation or rehearsal, selective confirming of hypotheses, loss in control over reflection, lax criteria induced by low motivation, stress, distraction or drugs, poor coping skills or lack of alternative hypotheses for dealing with potentially dysfunctional cognitions and emotions, social isolation, or dysfunctional social support for delusional ideas.

Using Source Monitoring to Frame and Explore Other Issues

There are a number of cognitive, social, clinical, developmental, and neuropsychological research areas where identifying the origin of mental experiences is a critical component. Thus, the source-monitoring framework might productively be brought to bear and might be further developed in return. Among these are: hindsight bias, impact of fiction on beliefs, development and maintenance of stereotypes, attribution of ideas (e.g., cryptomnesia, gender/race bias), spread of rumor, development of appearance–reality distinction and understanding of mental states such as dreams and imagination, hallucinations, and multiple-personality disorder. Consider two research areas that illustrate a productive intersection between interests and concepts arising from the study of source monitoring and the study of other issues: suggestibility effects (in eyewitness memory, interviewing child witnesses and therapy-assisted adult recovery of repressed memories) and cognitive deficits associated with aging.

Suggestibility. There are several areas in which false memories and beliefs resulting from reality-monitoring failures have been of particular interest recently. The source-monitoring framework has been used to investigate and characterize suggestibility effects in eyewitness testimony (Lindsay, 1993; Zaragoza & Lane, 1994). For example, Zaragoza and Lane compared the effects of introducing misleading information in the context of asking subjects questions (e.g., "When the man looked at his wristwatch before opening the door, did he appear anxious?") or in the context of a descriptive narrative ("When the man looked at his wristwatch before opening the door, he appeared very anxious"). They found that subjects were more likely to claim to have seen the wristwatch (which was not, in fact, in the original event) in the question than in the narrative condition. Zaragoza and Lane concluded that the way the misinformation was introduced influenced the qualitative characteristics of the memories for the suggested items, not memory for the occurrence of the information per se. They suggested that the questions induced the subjects to actively retrieve and reconstruct the original event, and then imagine the suggested information as part of their construction of the original event.

In part prompted by pressing questions about the veridicality of child testimony in sexual abuse cases, researchers have attempted to assess the accuracy of children's memory for complex events, including their susceptibility to suggestion (Ceci & Bruck, 1993; Goodman, Hirschman, Hepps, & Rudy, 1991). In a particularly striking example of fabricated memories resulting from suggestion, Ceci, Crotteau Huffman, Smith, and Loftus (1994) asked children to think about some events that had happened to them and some events that had never happened (e.g., "Did you ever get your hand caught in a mousetrap and have to go to the hospital to get it off?"). Children were asked about these real and fictional events once a week for several weeks. At the last session, children were asked to tell which events really happened and to describe them. A number of children claimed they remembered the false events (although they had denied them initially), and gave considerable detail about them. Furthermore, the detail appeared to develop with rehearsals of the events (see also Suengas & Johnson, 1988).

Subsequently, Ceci, Loftus, Leichtman, and Bruck (1994) conducted a similar study, but told children the fictional events actually happened and asked them to create a visual picture of the events in their head. Children were asked to visualize the events and to describe them approximately once a week for 12 weeks. At the last session, a new interviewer told the children that the other interviewer had made some mistakes, and that some of the events had never really happened. Children made more "false assents" on the last session than they had initially. Most children were more likely to say that fictional neutral events and fictional positive events had happened than that fictional negative events had happened. Ceci and colleagues also showed videotapes of children from this and the previous experiment to clinicians and researchers, who could not discriminate accounts of real and fictional events above chance (cf. Johnson & Suengas, 1989).

Ceci et al. pointed out that, with repetition, the children's accounts became increasingly detailed, coherent, and vivid, much as Johnson (1988) suggested that delusions develop with rehearsal. As in the case of delusions, some children evidently developed the conviction that the fictional events had actually happened. As Ceci et al. emphasized, transcripts of therapists and investigators who work with children in child abuse cases indicate that these adults sometimes use techniques that could induce later reality-monitoring failures in the children. Perhaps the worst of these are encouraging children to imagine events and repeatedly questioning them in a leading manner, which suggests the types of answers or information expected.

The source-monitoring framework has also been used to explain how false memories might arise from therapeutic practices used to help patients recover repressed memories (Belli & Loftus, 1994; Lindsay & Read, 1994). For example, to help patients remember forgotten events, some therapists (a) question patients under hypnosis, (b) encourage patients to believe that dreams reflect real events or use dreams to cue the recall of real events, (c) use guided imagery, (d) encourage patients to join abuse survivor support groups in which they hear many accounts of abuse, and (e) assign self-help books that include statements such as, "If you think you were abused and your life shows the symptoms, then you were" (Bass & Davis, 1988, p. 22). In a recent survey (Poole, Lindsay, Memon, & Bull, 1995), 7% of the licensed therapists who responded reported using at least one of these techniques, although there was also considerable disagreement about the advisability of a number of them. Regardless of whether these techniques sometimes result in recovery of accurate forgotten memories, it is clear that they encourage clients to (a) develop abuse schemas for interpreting the memories, emotions, and physical symptoms they do have; (b) vividly and repeatedly imagine events they are not sure happened; (c) adopt very lax criteria for generating ideas about what might have happened and for evaluating the veridicality of memories and beliefs; and (d) encourage them to give great weight to emotion as a cue to veridicality. All of these factors, along with the authority and social support of the therapist, would be expected to promote reality-monitoring errors. Thus, these practices should be used cautiously, if at all (Belli & Loftus, 1994; Lindsay & Read, 1994; Loftus, 1993; Poole et al., 1995).

One question of both theoretical and practical concern is, who is most "at risk" from potentially suggestive therapeutic practices, or from stories of child abuse in the media, novels, and movies? Does education inoculate some individuals better than others against induced false memories and beliefs? Undoubtedly there are some patients who have not been abused who would not come to believe they were even after many months of suggestive practices. However, there may be others who have not been abused who might relatively easily develop false memories or false beliefs about abuse.[2] Similarly, not all subjects show source confusions in laboratory studies of either simple, neutral mate-

[2]Suggestibility of some individuals is not an argument against responsible discussions of child abuse any more than hypochondria is an argument against responsible health information.

rials, such as perceived and imagined pictures, nor of autobiographical recall of suggested events. There may be correlations among some measures of source-monitoring confusions and individuals' scores on measures assessing social conformity, suggestibility, hypnotic responsiveness, and the degree to which they are vivid imagers or "fantasy-prone" (e.g., Wilson & Barber, 1983). Also, studies of individual differences might be a way to test the idea that developing false memories and beliefs is aided by, but does not depend on, vivid imagery; compelling interpretive experiences may be sufficient as well (Johnson, 1988).

Aging and Source Monitoring. Aging does not appear to produce uniform deficits in cognitive tasks, but rather disrupts some types more than others. For example, event memory appears to be more disrupted than does the kind of memory that underlies priming on implicit tasks (Light, 1991). As indicated by the earlier discussion of the source-monitoring framework, a memory for an event is the outcome of many factors operating at encoding, during the retention interval, and while the individual is remembering. Thus, accounting for age differences in event memory means specifying which of these factors is more likely than others to show changes with age.

As a beginning, it appears that age-related deficits in memory for source (context) tend to be greater than age-related deficits in memory for content (for a review and meta-analysis, see Spencer & Raz, 1995). For example, Ferguson et al. (1992) found that, even when younger and older adults were equated on old–new recognition, older adults were poorer at identifying which of two similar speakers had said particular words (also see Light, 1991; Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991). The cognitive mechanisms of age-related differences in memory for context are not completely understood (e.g., Spencer & Raz, 1995), but the source-monitoring framework provides guidelines for approaching the question systematically.

First, one might expect that some age differences are related to efficacy of binding processes during initial encoding. This hypothesis has been explored by Chalfonte and Johnson (1995, 1996). Chalfonte and Johnson pointed out that many studies of aging and context/source memory do not separate potential deficits in encoding features from potential deficits in binding features together. They tested these two factors separately and found that, relative to young adults, elderly subjects had a greater recognition memory deficit on the feature of location, but not a greater deficit on the feature of color. Thus, these two attributes do not appear to show a uniform disruption with age. However, Chalfonte and Johnson also found that elderly subjects had deficits binding either location or color to content. De Leonardis (1996) had subjects perform specific cognitive operations (orienting tasks) on words said by two speakers. Then subjects were asked to identify either the speaker or the cognitive operation engaged for each item. De Leonardis found that elderly adults showed equal deficits relative to young adults on both identification tasks. In general, such findings point to the necessity of comparing source deficits in more detail and distinguishing between feature encoding and binding deficits, both of which may be produced by aging.

In addition to potential differences in the efficacy of binding processes in younger and older adults, there may be differences in the aspects of experiences they reactivate and retrieve (i.e., ruminate and talk about) later. For example, Hashtroudi, Johnson, Vnek, and Ferguson (1994) had pairs of subjects act in a short play (Phase 1), think about it afterward (Phase 2), and then attempt to identify who said which lines on a surprise source-monitoring test (Phase 3). Older adults were less accurate than younger adults at source monitoring in Phase 3, if they had been instructed to think about how they had felt during the play or if they had been simply instructed to think about the play with no particular focus suggested in Phase 2. In contrast, when subjects were instructed to think about factual aspects of the play (e.g., what people said), older adults and younger adults did not differ significantly in their ability to discriminate their lines from the other actors. Therefore, at least some age-related deficits in source monitoring may reflect differences in what interests older and younger individuals, and thus what they think about (i.e., what receives reflective processing).

Older and younger adults may also apply different criteria in making source attributions. Available evidence suggests that older adults, like younger adults, show improved source accuracy when test conditions are changed from encouraging familiarity-based responding to making more stringent analyses of source-specifying characteristics of memories (Multhaup, 1995; Multhaup, De Leonardis, Johnson, Brown, & Hashtroudi, 1996). At the same time, there is some evidence that older adults may differentially weight different dimensions. For example, in one study, the correlation between subjects' rating of the perceptual clarity of their memories and their certainty in the accuracy of their memories was approximately the same for older and younger adults, whereas the correlation between subjects' ratings of the amount of emotion in their memories and their certainty in the accuracy of their memories was higher for older than for younger adults (Hashtroudi, Johnson, & Chrosniak; cited in Johnson & Multhaup, 1992). This finding suggests that, under some circumstances, older adults may give greater weight to emotional than to more factual inforn ation in evaluating the veridicality of memories. These and other potential age-related differences in how memories are rehearsed and evaluated await further study.

Although it is clear that some age-related deficits in source memory are related to age-related differences in what individuals focus on either at encoding, during the retention interval, or at test, this is likely not the whole problem. When encoding processes are more controlled, older adults still show deficits for bound feature information (Chalfonte & Johnson, 1996; De Leonardis, 1996), which appear to be greater the more similar the sources to be discriminated (Ferguson et al., 1992). Furthermore, when older individuals are engaged in a cognitive task that does not induce binding of content and perceptual features, they appear to suffer a disproportionate deficit from the addition of the cognitive task (Johnson, De Leonardis, et al., 1995). The extent to which age-related deficits reflect incidental binding deficits or deficits in more reflectively guided binding processes remains to be sorted out.

One potential benefit from a more detailed understanding of age-related changes in source memory is that aging is also associated with certain changes in brain structures, and thus might help clarify the neuropsychology of source monitoring. Two types of findings are particularly relevant: Older adults show evidence of neuropathology (e.g., cell loss, amyloid plaques, granulovacuolar degeneration) in the hippocampal system (Ivy, MacLeod, Petit, & Markus, 1992). In addition, physiological and behavioral studies suggest that the frontal cortex is particularly sensitive to the effects of aging (Albert & Kaplan, 1980; Gerard & Weisberg, 1986; Haug et al., 1983; Kemper, 1984; McEntree & Crook, 1990; Woodruff, 1982). Some evidence that age-related declines in source monitoring are associated with deficits in frontal lobe functioning were provided by Craik, Morris, Morris, and Loewen (1990). They found that older subjects' ability to identify whether a fact was learned in the experiment or outside the experiment was negatively correlated with perseverative errors on the Wisconsin Card Sort Test (WCST) and positively with performance on a verbal fluency test (two standard neuropsychological tests used to assess frontal function). However, Johnson et al. (1995) did not find a significant correlation between either older subjects' WCST or fluency tests and subjects' scores on a source test that asked them to identify who had said particular words. Given the complexity of attributes that go into making up source (i.e., that make up an event or episode) and the lack of precision of frontal tests, variations in outcomes should not be too surprising. Nevertheless, as is discussed next, it is quite plausible that some of the source-monitoring deficit associated with aging could arise from dysfunction of hippocampal and frontal systems.

BRAIN MECHANISMS OF SOURCE MEMORY

Current conceptions about the neural mechanisms underlying memory for source come primarily from studies of brain-damaged patients who show marked failures of source monitoring of various types (e.g., amnesics, frontal patients, Capgras' patients, and anosognosia patients). The cumulative evidence from these strikingly different patient populations points to two brain regions that are critical for creating, providing access to, and monitoring memory for events: the medial-temporal region, particularly the hippocampal system, and the prefrontal cortex.

Medial-Temporal Regions and Source Memory

The role of the medial-temporal brain areas, and especially the hippocampus, in memory for events has been well documented (e.g., Milner, 1970; Squire, 1983, 1987). Although the specific cognitive processes mediated by the hippocampal system that account for event memory are not entirely clear, this region appears to be critical for two types of functions: feature binding and reactivating. These functions are undoubtedly interrelated, but for ease of discussion are considered separately.

The Hippocampal System and Feature Binding. Several investigators have proposed that medial-temporal brain areas, especially the hippocampal system, play a central role in binding features together into complex eventlike memories (e.g., Cohen & Eichenbaum, 1993; Johnson & Chalfonte, 1994; Metcalfe, Cottrell, & Mencl, 1992). These ideas are similar to earlier theories of amnesia, which proposed that amnesics have deficits in context memory (Hirst, 1982; Mayes, 1988). Evidence regarding the context-deficit hypothesis has been equivocal because of (a) methodological issues regarding how it should be tested (e.g., see Chalfonte, Verfaellie, Johnson, & Reiss, in press), and (b) the suggestion that only amnesics with frontal damage in addition to medial-temporal damage show contextual deficits that are larger than their deficits on memory for the semantic content of items (Shimamura & Squire, 1987). However, it is increasingly clear that both content and contextual (or source) deficits can come about in more than one way, and thus a model that attributes content memory to the hippocampus and context (or source) memory to the frontal lobes is an oversimplification (Johnson et al., 1993). Consequently, this section considers the roles that both medial-temporal and frontal regions might play in establishing, retaining, reviving, and evaluating memories for events (i.e., memories that have phenomenal attributes of source).

Recent studies by Chalfonte et al. (in press) and Kroll, Knight, Metcalfe, Wolf, and Tulving (in press) illustrate the possible role of the hippocampal system in feature binding. Chalfonte et al. showed subjects a 7 × 7 array with pictures in some, but not all, locations. Subsequently, subjects were given an old–new recognition test for which items had been present, or a recognition test that required them to identify both an item and its correct location. Amnesics with presumed hippocampal system damage, but not Korsakoff's amnesics, tended to show a disproportionate deficit in their memory for the locations of items relative to their memory for the items. Chalfonte et al. proposed that the hippocampal system is involved in coding the feature of location, as well as in the incidental binding of item and location (cf. O'Keefe & Nadel, 1978). They further proposed that the hippocampus is part of a circuit along with other medial-temporal areas, including diencephalic regions, which operates in the binding of features in general—hence the general similarity of the deficits from amnesias of various etiologies and the extra memory deficit that patients with hippocampal damage seem to show.

Other evidence implicating the hippocampus in binding has recently been reported by Kroll et al. (1996). Kroll et al. showed subjects two-syllable words (Experiment 1) and tested recognition memory. Subjects were more likely to have false alarms to re-paired elements of stimuli than to completely new items, suggesting features were remembered, but their connections were not. Furthermore, this effect was exaggerated in left-hippocampal subjects relative to right-hippocampal subjects or normal controls. A second experiment using drawings of faces found false recognitions of re-pairings of elements to be higher than normal controls in both left- and right-hemisphere-damaged patients. Kroll et al. suggested that the hippocampus plays a critical role in "binding of informational elements into coherent, separately accessible, long-term engrams" (p. 194). Kroll et al.'s idea of binding is similar to the perceptual binding we have proposed—a binding process that can be set in motion by purely perceptual processes resulting from a single exposure (Johnson, 1992; Johnson & Chalfonte, 1994). However, we postulate that binding is also augmented when perceptual records are the target of further reflective processing. Both types of binding—perceptual and reflective—may be hippocampally dependent and time limited (see also Rovee-Collier, 1990).

The Hippocampus and Reactivating. Johnson and Hirst (1991, 1993; see also Johnson & Chalfonte, 1994) suggested that the hippocampus is part of a neural circuit that underlies the component process of *reactivating*. Reactivating is distinguished from *refreshing*, *rehearsing*, and *retrieving* in the typical time frame and activation levels of the target representation over which the various component processes are presumed to operate, and the degree of cuing required. As described in a previous section, *refreshing* and *rehearsing* operate on information that is currently in a state of relatively high activation, whereas *reactivating* and *retrieving* operate on information that is in an inactive state (or functionally a low state of activation). This means that *refreshing* and *rehearsing* typically operate during and shortly after a stimulus occurs, whereas *reactivating* and *retrieving* typically operate somewhat later.

However, what is critical for whether reactivating (rather than refreshing or rehearsing) occurs is whether the stimulus is a target of current perceptual or reflective processing, not whether it is physically present in the environment. For example, reactivation might occur when a subject reads a sentence that cues the recollection of a related point from an earlier paragraph on the same page. In this case, the reactivated item is available in the immediate environment, but not cognitively present until it is reactivated. Reactivating is accomplished as an R-1 process via current cues (in combination with current agendas), whereas retrieving (R-2) requires additional reflective input, such as self-generated cues or a recall strategy (e.g., let me try to recall what else I've read by this author).

From the MEM perspective, reactivations are a central mechanism of memory consolidation and, along with organizational processes (i.e., *shifting, noting, initiating, discovering*), largely determine whether memories will, on later occasions, be accessible via *reactivation* and *retrieval* (e.g., Johnson, 1992). Representations that do not undergo such reactivations may persist in the memory system, and perhaps be manifested in thought and behavior (e.g., Eich, 1984; DeSchepper & Treisman, 1996), or perhaps yield familiarity responses if encountered again. Nevertheless, they will not become part of one's autobiographical repertoire of event memories (Nelson, 1993) or stock of voluntarily accessible knowledge (e.g., Hogan & Kintsch, 1971; Landauer & Bjork, 1978). Thus, at least some of the profound effects of medial-temporal brain damage on acquiring new factual or autobiographical memories could be accounted for by a deficit in the component process of *reactivating* (Johnson & Chalfonte, 1994; Johnson & Hirst, 1991). The activation of information via more complex, strategic *retrieving* is dependent on frontal systems of the brain (Johnson, 1990; Schacter, 1987; Shimamura, Janowsky, & Squire, 1991). Similar to the distinction between *reactivating* and *retrieving* based on the MEM framework, Moscovitch (1992) suggested a distinction between associative (cue-driven) and strategic retrieval, the former mediated by the hippocampal system and the latter mediated by the frontal system.

Frontal Regions and Source Memory

There is general consensus about the types of activities that frontal systems are critical for: planning, self-regulation, maintenance of nonautomatic cognitive or behavioral set, sustained mental activity, and organization of events (Daigneault, Braun, & Whitaker, 1992; Stuss & Benson, 1986). Several important theoretical ideas about the cognitive mechanisms underlying these activities have also been proposed, including Baddeley's (1986) working memory, Goldman-Rakic's (1987) representational memory, Norman and Shallice's (1986) Supervisory Attentional System, and Stuss' (1991) reflectiveness system. These constructs can be organized by the MEM architecture to provide a unifying model of frontal functions expressed in terms of a set of component cognitive processes with memory outcomes.

For example, consider Goldman-Rakic's (1987) model of prefrontal cortex (PFC) functions (see also Daigneault et al., 1992; Weinberger, 1993). According to Goldman-Rakic, the PFC keeps representations (either perceptual or symbolic) in an active state so that they can modulate behavior. This allows behavior to be guided in the absence of current external stimuli. Furthermore, there is no central executive or unitary processor (see also Johnson & Reeder, in press), but rather multiple specialized processes identified with various prefrontal subdivisions that are dedicated to particular informational domains (Goldman-Rakic, 1995). Goldman-Rakic likened these specialized processors to a "working memory" (Baddeley, 1986). Similarly, Fuster (1995) suggested that the PFC performs the function of working memory, plus maintains a "preparatory set." There are a number of lines of evidence for this view; in particular, cortical neurons in PFC remain active after the offset of a stimulus (Goldman-Rakic, 1987; Fuster, 1989). The constructs of *working memory* or a *maintained representation* correspond in MEM to processes that maintain activation of target records through *refreshing* or *rehearsing*. The construct of *preparatory set* (Fuster) or *active schema* (Shallice) correspond to *agendas*. Presumably, different component processes in the reflective subsystems of MEM are associated with activation in PFC. Furthermore, the different cognitive processes postulated in MEM are realized via different circuits depending on the intra- and extrafrontal regions that are also recruited as part of a particular circuit. Because the PFC has connections with many other brain regions, it could perform the variety of functions required by R-1 and R-2 subsystems (e.g., see also Desimone & Duncan, 1995). Also, PFC functions can be usefully discussed with the mid-level concepts proposed in MEM. That is, the PFC appears to receive information to which meaning has already been

imparted (e.g., after the P-2 process of *identifying* has created a representation), and to intend behavior at the level of complex acts (e.g., "chair") and not specific movements (move tongue and lips; cf. Weinberger, 1993).

Other functions typically attributed to the PFC, in addition to maintaining information in an active state (e.g., deciding, planning, sequencing, self-control, and consciousness), have been described in terms of MEM as well. For example, Johnson and Reeder (in press) proposed that self-control arises from one reflective subsystem monitoring and controlling the other (e.g., R-1 by R-2).

The component processes in MEM's reflective subsystems should not be thought of as "in" the PFC, but rather as transactions between different frontal areas or between frontal regions and extrafrontal brain regions (e.g., temporal, parietal). For example, a circuit involving the occipital-parietal regions appears to be involved in the perceptual representation of spatial relations among meaningful objects (e.g., *identifying* and *placing*; Kolb & Whishaw, 1990). It is suggested here that various regions of the PFC are required for *refreshing*, *rehearsing*, *reactivating*, or *retrieving* such representations. Similarly, other regions of the PFC are required for *shifting*, *initiating*, *noting*, or *discovering* spatial relationships between spatially represented objects. In fact, one region of the PFC may take the representations held active by another region of the PFC and make comparisons among them via *noting* and *shifting* processes. This would constitute the type of transaction between R-1 and R-2 that Johnson and Reeder described in more detail. Finally, all such transactions are presumably guided by agendas (e.g., Furster's "prepatory set" or Shallice's "schemas") that are also active in areas of the PFC. Other regions of the PFC and other brain areas (e.g., temporal) would be involved in circuits for *refreshing*, *rehearsing*, *reactivating*, or *retrieving* representations of, say, verbal information, and yet others would be required for *shifting*, *initiating*, *noting*, or *discovering* symbolic relations among the representations of verbal information.

Furthermore, the agendas that recruit component cognitive processes in MEM are activated and maintained, in part, by emotional/motivational factors, which are served by limbic-hypothalamic circuits projecting to the orbital PFC. The motoric actions initiated as a consequence of the outcomes of perceptual and reflective processes recruited in the service of agendas are mediated by projections to the motor cortex (Kolb & Whishaw, 1990; Weinberger, 1993). Clearly, the hippocampal system participates in some, but not all, of these circuits. For example, we postulated that the hippocampus participates with PFC in *reactivation* circuits, by which ongoing agendas combine with other current cues (both external and internal) to revive bound feature combinations that people experience as event memories (i.e., that people attribute to a particular source; Johnson & Chalfonte, 1994; Johnson & Hirst, 1991).

In MEM, self-consciousness, self-control, and other such recursive instances of monitoring and control (e.g., awareness of awareness) are achieved by transactions between R-1 and R-2 subsystems. One possibility is that R-1 and R-2 processes are associated with the right and left PFC, respectively. This distinction fits the common characterization of right-hemisphere processes as more heuristic and holistic and left-hemisphere processes as more systematic, analytic, and planful. This could also account for certain disruptions of consciousness that occur when the two hemispheres are disconnected (Springer & Deutsch, 1985) because many aspects of consciousness require R-1/R-2 transactions (Johnson & Reeder, in press). However, an interesting alternative is that R-1 and R-2 functions are both represented in both hemispheres, but disproportionately so (e.g., Kolb & Whishaw, 1990). That is, the right hemisphere typically may be relatively more dedicated to R-1 functions and the left relatively more to R-2 functions. Variations in the balance may account for certain individual differences in which types of information are processed holistically and which analytically.

Considering the cognitive architecture depicted in MEM, it is easy to see why the frontal lobes have been clinically implicated in so many aspects of cognition, personality, and behavior, including problem solving and memory, regulation of thought, emotion and action, and consciousness (e.g., Stuss & Benson, 1986). This is because the R-1 and R-2 reflective component processes that sustain, revive, and organize information, and the learned agendas that recruit these processes in the service of motivationally significant goals, underlie all functionally adaptive learned thought and behavior.

The fact that no single, relatively small region of the PFC can be identified with a single executive controlling all frontal functions accounts for why so-called "frontal tests" are not always correlated with each other nor with performance on a particular experimental task, such as source monitoring. For example, Moscovitch, Osimani, Wortzman, and Freedman (1990) reported a frontal patient who was impaired on a verbal fluency (FAS) test, but not on the Wisconsin Card Sort Test (see also Parkin, Yeomans, & Bindschaedler, 1994). Frontal tests have been clinically useful despite this lack of precision in what they measure. They are complex enough to involve several processes (e.g., WCST), any one of which might be disrupted by frontal damage (e.g., motivation, maintenance of set, ability to refresh or rehearse outcomes, etc.). In addition, patients' lesions are often large enough to encompass the more limited functions that certain frontal tasks assess (e.g., FAS).

With this characterization of frontal function in mind, it is easy to see that frontal lobe damage might produce deficits in source monitoring for any one (or more) of a variety of reasons (Johnson, 1991a). Frontal deficits could disrupt reflectively promoted binding by disrupting consolidation, which would normally result from *reactivating* and *retrieving*. Frontal deficits could also disrupt the ability to hold alternative representations active by *refreshing* and *noting* relations between them. Comparing representations is essential for discovering contradictions that could lead one to reject information that otherwise seems compelling (e.g., on the basis of its clarity of perceptual detail). Frontal damage could disrupt the ability to strategically *retrieve* additional confirming or disconfirming evidence—again, evidence that would be critical for evaluating other evidence pointing to a particular source. Furthermore, frontal damage could produce changes in motivation that might induce lax source-monitoring criteria (e.g., lack of concern with inconsistency). Insofar as frontal deficits disrupt interactions between R-1 and R-2, access to records of cognition operations might be disrupted, making it more difficult to identify oneself as the origin of remembered information.

Consistent with this picture of multiple mechanisms for disrupting source monitoring, clinical cases of disrupted source monitoring are extremely variable in their characteristics. Cases vary in the frequency of confabulation, how mundane or bizarre the confabulations are, and how long the period of confabulation lasts (e.g., Johnson, 1991a; Kopelman, 1987). They have been attributed to various types of "executive" disorders, including deficits in ability to self-monitor and indifference (e.g., Kapur & Coughlan, 1980; Stuss et al., 1978). The more severe and longer lasting forms of confabulation appear to be associated with large lesions that disrupt both the medial-basal forebrain and frontal cognitive systems. Less severe, more transient confabulation appears to result from lesions limited to basal forebrain or orbital-frontal cortex. However, "The precise location and extent of frontal damage necessary for the development of the executive systems deficits specific or sufficient for the emergence of spontaneous confabulation are not known" (Fischer, Alexander, D'Esposito, & Otto, 1995, p. 27).

In trying to link brain regions to complex behavior like confabulation, part of the problem (as this analysis of source monitoring makes clear) is that there is no single, simple cognitive factor producing confabulation and delusions. For example, Johnson, O'Connor, and Cantor (1995) explored cognitive deficits underlying confabulation of a patient, GS, following an anterior communicating artery aneurysm that produced frontal damage. We compared GS with three nonconfabulating frontal patients matched for age, education, and neuropsychological measures of memory and frontal deficits, and with three age- and education-matched control subjects. Like frontal controls, GS underestimated temporal durations and showed poor source memory (speaker identification). What distinguished GS from the frontal controls was that his deficit in autobiographical recall was even greater than theirs, and his recall of laboratory-induced memories for imagined events was more detailed. We suggested that any one factor (e.g., deficits in source memory, deficits in ability to recall autobiographical memory, and propensity toward detailed imaginations) alone might not produce confabulation, but an interaction among these tendencies could disrupt a patient's ability to discriminate fact from fantasy.

The study of GS also highlights another important fact: All the patients had frontal damage, but only GS showed a clinically significant degree of confabulation. That is, not all "frontal syndrome" patients confabulate (Stuss & Benson, 1986). Standard diagnostic tests for frontal symptoms alone do not differentiate between frontal patients who confabulate and those who do not. In addition, although GS and the frontal controls were matched on neuropsychological tests of memory and attention/executive function, they were not matched on location of lesion. A given neuropsychological profile is only a rough index of associated brain damage. All three frontal controls had evidence of left frontal lesions on computerized tomography (CT) scan, whereas GS's CT scan revealed bilateral frontal lesions. Thus, it is tempting to attribute GS's confabulation to right frontal lesions. However, confabulation has been observed in patients with left frontal damage (e.g., DeLuca & Cicerone, 1991; Kapur & Coughlan, 1980), as well as those with right or bilateral damage (e.g., Joseph, 1986; Moscovitch, 1989). Hence, right frontal damage does not appear to be a necessary condition for confabulation (see also Fischer et al., 1995).

An intriguing possibility is that GS's poor autobiographical recall was related to the damage to his right PFC (Tulving, Kapur, Craik, Moscovitch, & Houle, 1994). Tulving et al. reviewed available published studies, and noted that right frontal damage seems to be correlated with deficits in retrieval (whereas left frontal damage seems to be correlated with encoding deficits). Johnson, O'Connor, and Cantor (1995) suggested that any detailed apparent memory (whether real or invented) might stand out against a background of impoverished autobiographical recall. Bilateral frontal damage may then disrupt the R-1/R-2 interactions necessary for critically evaluating activated information or holding it active while other confirming and/or disconfirming evidence is retrieved.

Although confabulation does not appear to result from right frontal damage alone, right-hemisphere damage is often associated with various forms of confabulation or deficits in reality monitoring (e.g., anosognosia accompanying hemiopia or hemiplegia). For example, consider *Capgras syndrome*, in which a patient believes that a person, usually someone close, has been replaced by someone similar—a double or impostor. The patient will say that the "impostor" looks like the "replaced" person, but the patient claims to know the "impostor" is not that person. Although initially thought to be a symptom associated with functional psychopathology, more recently, case descriptions and theoretical analyses have emphasized the possible organic basis of Capgras syndrome.

Ellis and Young (1990) pointed out that a Capgras patient seems to "recognize" the double as like the target person, but not to have the appropriate associated affect that is normally part of the familiarity response to a known person. They suggested that Capgras results from damage or disconnection within a neurological pathway signaling either emotional significance or familiarity. Ellis and Young also suggested that deficits in a face-recognition system combine with a tendency toward persecutory delusions to generate the Capgras delusion. That is, patients "mistake a change in themselves for a change in others (i.e., because altered affective reactions make people seem strange, they must have been 'replaced')." An anomalous perceptual experience combines with an incorrect interpretation (see also Johnson, 1988; Maher, 1974). Thus, Ellis and Young posited that a disordered face-detection system is combined with a disordered self-analysis or judgment system (Benson & Stuss, 1990) to produce the delusion. In MEM, the face-detection system would be a subdomain of the P-1 and P-2 subsystems (e.g., involving the component process of identifying), and the judgment system would reflect R-1 and R-2 processing. Consistent with Ellis and Young's analysis, Capgras patients score poorly on unfamiliar face recognition or matching, and Capgras delusion is associated with right temporal damage compounded with superimposed frontal dysfunction (Cutting, 1990; Ellis & Young, 1990; Joseph, 1986).

Finally, consider a case recently described by Kopelman, Guinan, and Lewis (1995). Their patient, WM, is a woman with the delusion that she has a relationship with a famous orchestral conductor (she was diagnosed with De Clerambault's syndrome secondary to schizophrenia). WM believes the relationship began many years before when they saw each other at a fruit-picking farm in East Anglia. According to her, they exchanged no words then, but he subsequently followed her to London and another town, but then stopped pursuing her. She believes they will be married someday, writes to him regularly, and believes they experience each other's thoughts. Unfortunately, Kopelman et al. could not get a scan for this patient, but she scored normally on IQ tests and, notably, on tests of frontal lobe function (e.g., FAS, cognitive estimates, card sorting). Kopelman et al. suggested that, although these delusions might superficially resemble confabulation associated with organic damage, they may arise somewhat differently. Confabulations often represent a "process of disorganized, out-of-context, and incoherent retrieval of past memories," whereas delusional memories may arise from a "predisposition to interpret the external world in particular ways, contingent upon underlying affective or cognitive factors. . . . " (p. 75). Kopelman et al. suggested that frontal deficits are responsible for decontextualized and incoherent memories, but not for "slippage" in interpretive schemas. However, as Ellis and Young's account of Capgras patients suggested, they too appear to have some "slippage" in interpretive schemas.

Interestingly, although WM scored at the 92nd percentile on recognition memory for words, she scored at only the 23rd percentile on recognition memory for faces. This poor recognition of faces is quite interesting (cf. Ellis & Young, 1990). It suggests that WM might have seen someone in East Anglia who resembled the conductor, exchanged what she took to be (or which were) meaningful looks with that person, and begun a rich fantasy about subsequent events. Similarly, she could have subsequently "recognized" the conductor in other faces, supporting the belief that he was showing an interest in her by following her. Clearly, poor face recognition alone would not be enough to support an elaborate delusion, but delusional thinking might well have taken "advantage" of the opportunity presented by poor face recognition (cf. Maher, 1974; Maher & Ross, 1984, for discussion of the idea that delusions sometimes arise around anomolous perceptual experiences).[3]

Nevertheless, as Kopelman et al. (1995) suggested, there is an important distinction between disordered memories and beliefs that arise because of organically caused deficits in memory and cognition (e.g., a deficit in strategic retrieving, an inability to prolong activation via refreshing) and disordered memories and beliefs that arise because of deficient use of intact mechanisms. These nonorganic deficiencies can come about for many reasons, including skewed schemas resulting from ignorance of facts and social support for bizarre beliefs. Both Kopelman et al. and Ellis and Young illustrated the potential value of combining cognitive neuropsychology and what Ellis and de Pauw (1994) called *cognitive neuropsychiatry*, in which biological, cognitive, motivational, and social factors are all taken into account in understanding a pattern of symptoms. This same multilevel approach should be productive in considering the complete range of situations in which issues of source monitoring arise, including eyewitness testimony; children's accounts of abuse; adult recovery of childhood memories; and hallucinations, delusions, and confabulations associated with psychopathology or organic causes.

[3]Another interesting possibility is that WM is a case of a fantasy-prone personality (Wilson & Barber, 1983).

Degrees of Frontal Deficits

Whether organically, psychodynamically, or socially based, confabulations, delusions, and other clinically significant reality-monitoring failures may reflect frontal dysfunction, but we might differentiate the type of frontal dysfunction by "degree" (analogous to burns). The most serious types of frontal deficits are "third degree." These arise from organically based disruptions in the underlying circuits that support certain cognitive activities. For example, lesions in some areas of the frontal lobes may disrupt the ability to hold verbal information online (i.e., *refresh* or *rehearse* it). Lesions in other prefrontal areas may disrupt the ability to shift to new ways of looking at a stimulus, or to new agendas or schemas.

However, lesions are not necessary—there are other ways to disrupt such "frontal" activities. If neurologically intact subjects are given a second, distracting task, such as monitoring an auditory sequence for combinations of odd digits (Craik, 1983) or performing a finger-tapping task (Moscovitch & Umilta, 1991), they will find it difficult to engage in reflective activities such as *refreshing*, *rehearsing*, *shifting*, and *noting*. Presumably, other conditions of distraction, such as depression or emotional stress, have similar disruptive consequences (e.g., Hasher & Zacks, 1979). In these nonlesion cases, there is a deficit in appropriate frontal processing as a secondary consequence of other factors—a second-degree frontal deficit.

Finally, consider cases in which people do not engage in reflective processing because they do not know how (e.g., children have to learn mnemonic techniques), do not know that it is appropriate, are not in the habit of doing so, or because they are not motivated to do so. These cases might be thought of as first-degree frontal deficits. In short, there are a number of ways to shut down or attenuate reflective activity.

Frontal Deficits of Different Degrees May Interact

Considering that there may be different degrees of frontal dysfunction highlights the possibility of considering the interaction of deficits of different degrees. For example, a lesion-induced third-degree deficit may produce different patterns depending on whether the patient has premorbid first-degree deficits. Furthermore, we would not expect frontal deficits of any degree necessarily to be general. For example, circumscribed frontal lesions may cause third-degree deficits in processing verbal, but not visual, information or vice versa. Certain types of distraction are more likely to produce second-degree deficits on some tasks than on others. An individual may be in the habit of dealing reflectively with job-related information, but not personal interactions or vice versa (i.e., first-degree reflective deficits may be evident in some areas, but not others). Hence, we should find premorbid individual characteristics affecting how the consequences of frontal damage are manifested (e.g., O'Connor, Walbridge, Sandson, & Alexander, 1995). Such interactions may help account for the great variability in thought and behavior patterns shown by patients with frontal damage, as well as patients under stress or in a depressed state.

FINAL REMARKS

To survive, a cognitive system that takes in information from the external world and generates information itself has to have mechanisms for distinguishing the origin of information. This chapter gives an overview of the approach my colleagues and I have developed for exploring how such discriminations are accomplished. We call this approach the *source-monitoring framework*, but perhaps we should call it the *source framework* because it includes more than a focus on the evaluative phase of remembering. It also includes proposals about the conditions for establishing complex event memories in the first place, and an emphasis on prior and subsequent events and mental processes (e.g., rumination), which can affect the likelihood that memories and beliefs will be veridical. We believe this approach can provide a framework for understanding the particular ways that source monitoring may be vulnerable to organic brain damage, social and cultural factors, and dysfunctional cognitive activities. Converging evidence from many investigators conducting controlled laboratory studies of cognitive and social processes, along with case studies and group studies of patients from various clinical populations, is moving us closer to an appreciation of the complex dynamics involved in attributing mental experiences to sources. Furthermore, although the source-monitoring framework has been most frequently applied to understanding memories for events and, to a lesser extent, attitudes or beliefs, an appropriately expanded source-monitoring framework should also be useful for investigating the processes involved in evaluating ongoing perception (reality testing; e.g., Perky, 1910) and future plans and expectations (reality checking; e.g., Johnson & Sherman, 1990).

With respect to event memory, we have attempted to specify the mechanisms by which event memories are established, maintained, revived, and evaluated. We have described these mechanisms in terms of a general cognitive architecture, MEM, which proposes a mid-level vocabulary for conceptualizing perceptual and reflective processes. Thus, we attempted to characterize relevant factors both in terms of the class of information that might be involved (e.g., a high level of perceptual detail) and the processes that might be involved (e.g., perceptual detail maintained through *reactivating* or perceptual detail embellished through *reactivating*, *shifting*, and *noting*). It provides a conceptual structure for generating experiments (e.g., investigating potential age-related differences in source memory, or suggestibility effects in eyewitness testimony or autobiographical memory). Furthermore, MEM component processes can be related to brain circuits involving structures such as the hippocampal and frontal systems, and processes such as binding and executive control, which appear to be central for identifying the sources of mental experiences.

Our goal is to clarify source memory without underestimating the complexity of the problem. For example, it is most natural to think of deficits or disruption as reducing or eliminating a particular type of cognitive activity. But it is important to remember that a cognitive deficit does not necessarily just leave a blank in the stream of consciousness where that cognitive process might otherwise have been. Deficits in processes may have a secondary effect of increasing other processes. If one's ability to remember past events is disrupted, one might ruminate or elaborate on what one does remember. If one's ability to anticipate and plan for future action is disrupted, one might obsess over current perceptions and thoughts. Furthermore, what one does think about then creates the background knowledge, beliefs, and schemas that "capture" new incoming information—selecting among elements, generating one interpretation over another, and perhaps triggering reactivation and retrieval of related thoughts.

Whether normal or disrupted, cognitive activity is embedded in motivational, social, and cultural contexts. Source monitoring accompanies all this cognitive activity, sometimes with conscious awareness and sometimes as part of the natural, ongoing use of available perceptual and memorial information—sometimes accurately, sometimes resulting in minor inaccuracies, and sometimes in serious distortions or extreme delusions. Because much can be learned about a process from looking at "normal" errors, or more serious errors that arise when the processes break down, research efforts tend to focus on producing and/or explaining errors and distortions. Nevertheless, we should not lose sight of the fact that the study of source monitoring reveals how processes work that generally allow people to accurately identify the origin of mental experiences, and to be appropriately cautious when information seems equivocal.

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