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Source Monitoring

Attributing Mental Experiences

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To understand the problems that source monitoring research and theory address, consider the implications of a cognitive system that is capable of construction and reconstruction—that is, capable of generating information on its own and integrating information from multiple sources. Constructive and reconstructive processes that interpret, embellish, transform, and synthesize experiences are powerful engines for comprehension and creativity, but the potential cost is distorted memories and beliefs (e.g., Bartlett, 1932/1995; Bransford & Johnson, 1973; Neisser, 1967).

The constructive view of cognition was fueled by many observations. Among the most important were the consequences of schema-driven (e.g., Bartlett, 1932/1995), associative (e.g., Deese, 1959), and organizational (e.g., Tulving, 1962) processes. For example, while inter-item associations contribute to accurate recall (e.g., Jenkins & Russell, 1952), associations with an item not on the list can produce intrusions (Deese, 1959). Thus, it has long been clear that similar mechanisms produce both *accurate* and *inaccurate* memory.

The impact of constructive and reconstructive processes was strikingly apparent in studies carried out in the late 1960s and early 70s that were concerned with the comprehension of, and memory for, prose. For example, shortly after reading a passage, changes in wording that alter meaning are typically rejected, but changes in wording that preserve meaning (i.e., paraphrases) are likely to be recognized as old (e.g., Sachs, 1967). People told that *there is a box to the right of a tree* and that *there is a chair on the box*, often remember that they heard that *the tree is to the left of the chair* (Bransford, Barclay, & Franks, 1972). A key message of such studies was that encoding is not simply associative; it also produces complex representations of entire situations that reflect real-world knowledge (e.g., of spatial relationships). Furthermore, constructive processes are not a luxury. They allow us to use activated relevant knowledge to interpret, integrate, and retrieve an otherwise incomprehensible event and, consequently, remember much more than we could otherwise (e.g., Bransford & Johnson, 1973).

At the same time, the information, knowledge, and beliefs that help us encode and remember events can also produce errors. For example, participants told that the main character of a story was Helen Keller were more likely to remember reading the nonpresented sentence *She was deaf, dumb, and blind* than a control group told the main character's name was Carol Harris (Sulin & Dooling, 1974). What is remembered may even distort the meaning behind the message. For example, people hearing a story that included the sen-

tence *The spy threw the secret document into the fireplace just in time since 30 seconds longer would have been too late* were later likely to falsely recognize a sentence that indicated that the spy burned the secret document (Johnson, Bransford, & Solomon, 1973). Thus, people were likely to make assumptions about the situation that might be incorrect (e.g., that a fire was lit in the fireplace and the spy wanted to destroy the document, whereas the fire might not have been lit and the spy might have wanted to hide the document) and these assumptions were taken by the rememberer to be part of the memory for the situation. Such memory distortions that go beyond logical paraphrase raise serious questions about the relation of a constructive memory system to reality. How does such a constructive memory system remain functional and not deteriorate into a pathological quagmire of real and imagined experience or recombinations of features of real experience?

The Johnson-Raye (1981) model of reality monitoring, and the more general source monitoring framework (SMF; Johnson, Hashtroudi, & Lindsay, 1993), are attempts to address this question. The proposed solution centers on the idea that construction and reconstruction alone do not create memory distortion. From both everyday experience and laboratory studies, it is clear that people sometimes succeed and sometimes fail at discriminating the origin of mental experiences. It follows that there must be mechanisms that allow us to discriminate correctly the origin of some mental experiences but not others. Johnson and colleagues proposed that these mechanisms are attributional judgment processes—that is, evaluative or monitoring processes by which mental experiences are attributed to different sources. Accordingly, constructions and reconstructions only constitute memory distortions when they are taken to be accurate memories.

The Source Monitoring Framework (SMF)

Memory representations reflect the processing activities occurring at acquisition (e.g., Johnson, 1983; Kolers & Roediger, 1984). According to the SMF, later activation of these representations (along with activation of other information at test) results in mental experiences that can range from general feelings of familiarity or strength to memory for specific features such as perceptual detail (e.g., color, shape), spatial and temporal information, semantic information, affective detail (e.g., emotional reactions), and the cognitive processes engaged (e.g., elaboration, retrieval of supporting information). Different types of acquisition processes (e.g., reading, thinking, inferring) and different types of events (e.g., movie, newspaper, dream) tend to produce memorial representations that are characteristically different from each other. For example, memories of imagined events typically have less vivid perceptual, temporal, and spatial information than perceived events and often include information about intentional cognitive operations (e.g., active generation and manipulation of visual images during problem solving). Memories of dreams are often perceptually vivid, typically do not include information about the cognitive operations that created them, and are often inconsistent with knowledge or other memories (Johnson, Kahan, & Raye, 1984). However, because of variability within these source types, the distributions of features of memories from different processes and events overlap. For example, representations of some perceived events are less detailed and perceptually vivid than representations of some imagined events. Some dreams are more plausible than some waking events. Thus, the characteristics of a mental experience cannot serve as a precise signature, or "tag," that specifies its origin. Rather, remembering always involves judgments about how the quantity and quality of these characteristics compare to expectations about characteristics of memories from various sources. So, for example, if a mental experience had substantial perceptual detail (e.g., visual), one would tend to attribute it to a perceived event (e.g., something one saw) since, on average, memories from perceived events contain quite a bit of perceptual detail.

Many source attributions are thus made rapidly and relatively nondeliberatively following the match-to-average-characteristics heuristic just described. However, the SMF posits that source monitoring sometimes also entails more systematic processes that are typically slower and more deliberate, involving, for example, retrieving additional information, discovering and noting relations, extended reasoning, and so on (see also Ross, 1997). Hence, even if you had a very vivid, perceptually rich memory of finding a money tree in the backyard, you might nonetheless accurately attribute that memory to a dream since you know

that money does not grow on trees and you could therefore reason that this would, unfortunately, be impossible (Johnson, 1985).

Both heuristic and systematic source attributions are affected by a rememberer's biases, goals, agendas, and meta-memory skills. For example, you would probably engage in more stringent evaluative processing if you were trying to remember who proposed an interesting new theoretical argument that you want to cite than if you were trying to determine who told a particularly funny joke that you want to retell.

In sum, the ability to identify accurately the source of a memory depends on the type, amount, and quality of activated memory characteristics, whether the characteristics uniquely specify the source, the efficacy of the judgment processes engaged, the weights assigned to different features of the mental experience, and the criteria used when making the source attribution. Of course, as imperfect judgment processes are applied to mental representations that are themselves imperfect (in the sense that they are not exact copies of events) some errors are bound to occur. A basic tenet of the SMF is that illusory memories and veridical memories normally arise via exactly the same mechanisms (Johnson et al., 1993; Johnson & Raye, 1998). Nevertheless, we can specify factors likely to promote source monitoring errors, and hence, memory distortion.

For example, factors that disrupt normal encoding processes that bind features into a complex memory have been shown to increase source errors leading to memory distortions. Study conditions such as divided attention (e.g., Jacoby, Woloshyn, & Kelley, 1989) and focusing on one's own emotions rather than event details (Hashtroudi, Johnson, Vnek, & Ferguson, 1994; Johnson, Nolde, & De Leonardis, 1996) increase source errors, presumably because useful source-specifying information fails to be, or is weakly, bound into the memory (for other evidence that disruptions in binding can lead to illusory memories see, for example, Kroll, Knight, Metcalfe, Wolf, & Tulving, 1996; Reinitz, Lammers, & Cochran, 1992). Likewise, factors that decrease the specificity, or diagnosticity, of available source information can lead to increased source memory errors—for example, increased semantic similarity of statements (e.g., Lindsay, Johnson, & Kwon, 1991), decreased temporal separation of word lists (e.g., Winograd, 1968), decreased salience of cognitive operations (e.g., Finke, Johnson, & Shyi, 1988; Rabinowitz, 1989), or a high degree of perceptual similarity between sources (Hashtroudi, Johnson, & Chrosniak, 1990; Johnson, Foley, & Leach, 1988; Lindsay et al., 1991). Similarly, factors at test that lead people to focus on less diagnostic memory characteristics also increase source misattributions (Marsh & Hicks, 1998). Factors that decrease the efficacy of the judgment process lead to increased errors—for example, inducing lax criteria, inappropriate feature weights, or less thorough evaluative processes (Dodson & Johnson, 1993; Lindsay & Johnson, 1989; Multhaup, 1995) or dividing attention at test (e.g., Dodson, Holland, & Shimamura, 1998; Dodson & Johnson, 1996; Gruppuso, Lindsay, & Kelley, 1997). Likewise, limiting the time available to make a source judgment is likely to negatively affect accuracy (e.g., Zaragoza & Lane, 1998). This last point is supported by studies using a response-signal method that shows that recognizing that an item is old typically precedes more specific source identification (Gronlund, Edwards, & Ohrt, 1997; Johnson, Kounios, & Reeder, 1994; see also Hintzman, chapter 11).

It should be noted that although explicit source identification tasks are often used to investigate memory distortion (see Johnson, 1997; Lindsay, 1994, for reviews), the SMF can be applied to a number of other attributional phenomena that result in illusory memories (e.g., *cryptomnesia*—that is, unconscious plagiarism; Marsh, Landau, & Hicks, 1997; misattributions in exclusion paradigms, such as the *false fame effect*; see Kelley & Jacoby, chapter 14; the *illusory truth effect*, in which participants' ratings of the truth [i.e., referential validity] of plausible statements about real-world situations increase with prior exposure, regardless of the actual truth of the statement; Bacon, 1979; Hasher, Goldstein, & Toppino, 1977). All of these phenomena reflect, in essence, source monitoring errors. Although not all of these paradigms are described as explicit source identification tasks, in some participants are told to avoid using information from a particular source in their answers (e.g., in cryptomnesia paradigms they are told to not give answers that have been previously provided), and all do, in fact, involve making attributions about the source of mental experiences.

We turn next to a specific class of source misattribution errors that has been especially well investigated—eyewitness suggestibility, or people's tendency to remember as part of

a witnessed event information that was only suggested to them afterward. Systematic application of the principles of the SMF in recent years has advanced our understanding of the mechanisms underlying this phenomenon.

Eyewitness Suggestibility as Source Monitoring Error

The memorial task for eyewitnesses is to a large extent a source monitoring one. They must differentiate details of a witnessed event from related details such as relevant prior memories, general knowledge about events such as crimes, and, of particular interest here, memories of crime-specific information they are exposed to after the witnessed event (e.g., via police questioning, media exposure, casual conversations). Misattributing information from any of these sources to the witnessed event could have serious consequences, especially in cases where false information has been introduced (e.g., via misleading questioning by police, lawyers).

Many studies demonstrate that eyewitnesses can be led to report postevent suggestions as part of their memory for a witnessed event (see Belli & Loftus, 1994; Lindsay, 1994; Loftus, 1993; Zaragoza, Lane, Ackil, & Chambers, 1997, for reviews). Although there has been substantial controversy over the status of the original memory of the witnessed event after exposure to suggestion (see Lindsay, 1994; Loftus, 1993; Zaragoza et al., 1997, for reviews), it has become widely accepted among researchers in the eyewitness memory domain that the misinformation effect reflects, in great part, source confusion. That is to say, participants misattribute a memory from one source (postevent questions) to another source (the witnessed event). Thus, recent work has centered on more clearly delineating the circumstances under which source misattribution errors might be expected to obtain, and the factors that serve to increase/decrease these errors, in an eyewitness situation.

To maximize accuracy, most suggestibility studies carried out from the source monitoring perspective employ an adaptation of the three-phase suggestibility procedure in which the source identification requirements are made as clear as possible. Participants first "witness" an event (e.g., video of a crime). Later, in the context of a postevent narrative or questions about what they saw, participants are exposed to some misleading suggestions (e.g., that the thief had a gun when, in fact, the thief had no weapon of any sort). During the test phase, participants are often explicitly informed that some of the information supplied in the postevent questions/narrative did not really appear in the original event (e.g., the video). They are then asked directly about their memory for the source of the suggestions (together with some filler items from the other source categories—that is, video only, both the video and questions, and new). Suggestibility is usually measured as participants' tendency to misattribute the misleading postevent information to the originally witnessed event (whether or not they also attribute it correctly to the postevent questions/narrative).[1]

Although the two events that need to be differentiated in an eyewitness situation (the originally witnessed event and the postevent questioning) should be clearly distinguishable in some respects (e.g., the first has richer visual detail), they share similar semantic information—including a common referent—and an abundance of contextual information (e.g., Lindsay, 1994). In fact, compared to actual eyewitness interrogations, objective overlap is maximized in the usual laboratory study because the postevent suggestions are typically embedded in a richly detailed account that essentially reinstates for the witness the event's contents and context (e.g., chronology). The fact that environmental context, such as the room and the experimenter, are typically also shared across the two events adds to the objective overlap. Given what we know about the effects of similarity in other source monitoring situations, perhaps it is not surprising that participants in suggestibility experiments become confused about the source of the suggested information. As mentioned earlier, evidence from other paradigms shows that increasing perceptual or semantic similarity between two sources increases the rate of source errors. For example, although people remembered the source of words quite well when they heard an experimenter read some of the words and imagined themselves saying some others, source errors increased when they were asked to distinguish between words the experimenter read aloud and words they imagined hearing *in the experimenter's voice* (Johnson et al., 1988). Likewise, increasing either the perceptual similarity of two speakers or the semantic similarity of the contents of their messages increases source errors (jointly increasing both forms of similarity makes the

discrimination especially difficult; Lindsay et al., 1991).

Mitchell and Zaragoza (1999) shed some light on the relative importance of various dimensions of similarity for source monitoring in an eyewitness situation. They showed that reducing objective overlap between the originally witnessed event (a video) and the misleading postevent questioning episode (i.e., amount of true content information, chronology, environmental context) did not significantly improve participants' ability to discriminate between the two events as the source of the suggestions. In explaining this counterintuitive finding, Mitchell and Zaragoza proposed that as people attempt to answer postevent questions about the video they must reflect back on and reactivate their memory of the witnessed event (and perhaps image the suggested information as well). They argued that this process of reactivating and reflecting back on the witnessed event during postevent questioning may increase the functional similarity of the two events because it affords an opportunity for the postevent suggestions to acquire specific characteristics typical of the originally witnessed event (such as a high degree of sensory/perceptual detail). Alternatively, or in addition, as witnesses answer questions, they may create a representation (semantic product or mental model; Bransford & Johnson, 1973; Johnson-Laird, 1983) that includes elements from both the witnessed event and the suggestion, effectively binding them together. Then, when they are tested with the misinformation, it may activate elements from the original event that in turn might be taken as evidence that the misinformation was part of the event. In effect, people may base their judgment on a representation of their constructed understanding of an event rather than a representation of the event itself (e.g., Johnson, 1983; Reyna & Titcomb, 1997).

Consistent with the idea that the cognitive processes invoked during the postevent will determine the magnitude of the source misattribution effect, Zaragoza and Lane (1994) found that a postevent task, such as answering questions about the video, which required participants to retrieve the originally witnessed event while processing the misleading information, resulted in significantly more source misattributions than a task that did not require that they necessarily reflect back on the witnessed event (i.e., reading the misleading postevent information as a narrative). Repeatedly engaging in such reflective processing (e.g., responding to multiple questions about a scene in the video) increases errors (Zaragoza & Mitchell, 1996). Thus, it may be that the functional (as opposed to objective) similarity in cases where multiple events have the same referent is largely determined by the nature of the reflective operations that take place as the events are processed.

The hypothesis that suggestibility errors in this paradigm sometimes arise from the misattribution of specific qualitative characteristics (e.g., imagined perceptual detail) rather than (or more likely in addition to) general attributes such as a strong sense of familiarity is supported by the fact that participants in eyewitness suggestibility studies sometimes rate their false memories with high confidence (e.g., Zaragoza & Lane, 1994; Zaragoza & Mitchell, 1996) and claim to specifically "recollect" seeing the suggested information in the video (e.g., Zaragoza & Mitchell, 1996). Similarly, in other source memory paradigms, confidence in source judgments tends to be associated with higher levels of rated detail (e.g, Hashtroudi et al., 1990).

This is not to say that familiarity is never the basis of eyewitnesses' source decisions. Consistent with the idea that familiarity may be used when people set lax criteria, source errors decrease when the test format leads participants to consider more detailed information (e.g., Lindsay & Johnson, 1989; Multhaup, De Leonardis, & Johnson, 1999; Zaragoza & Koshmider, 1989; see also Dodson & Johnson, 1993). Likewise, Chambers and Zaragoza (1993) showed that eyewitnesses' identification of the source of postevent suggestion improves when the source of the suggestion is explicitly discredited (see also, for example, Dodd & Bradshaw, 1980; Underwood & Pezdek, 1998), although the beneficial effects of this discrediting decay quickly, as in the *sleeper effect* (a social persuasion phenomenon reflecting source monitoring failure, in which the impact of a persuasive message from a discredited source increases over time because people remember the message but forget they had a reason to discount it; e.g., Pratkanis, Greenwald, Leippe, & Baumgardner, 1988). The SMF predicts that eyewitness suggestibility would increase in situations in which the rememberer has but does not, or cannot, use available information and knowledge to prevent a source error—for example, by retrieving and reasoning from additional information (Johnson, Foley, Suengas, & Raye,

1988; Lindsay, 1994; Zaragoza & Lane, 1994; see also Ross, 1997). And, in fact, suggestibility has been shown to increase under conditions of speeded responding (Zaragoza & Lane, 1998).

It is interesting to note that although participants in suggestibility studies may confidently say they remember the suggested information from the witnessed event, they often also indicate that they remember, at quite high levels, that the suggested information was read in the postevent questions/narrative (e.g., Belli, Lindsay, Gales, & McCarthy, 1994; Fiedler, Walther, Armbruster, Fay, & Naumann, 1996; Zaragoza & Mitchell, 1996). Thus, even if a witness to an actual crime knows full well that some piece of information occurred in the context of postevent questioning (or other postevent exposure such as media coverage), they may still come to remember it as part of the originally witnessed event. In fact, even when people knowingly confabulate about a witnessed event (i.e., they are forced to generate false information in response to forced-recall questions), they sometimes later come to misremember their own confabulations as part of the witnessed event (Ackil & Zaragoza, 1998). This is consistent with the general source monitoring literature, which shows that individuals' awareness of their own cognitive operations at time 1 will not necessarily protect them from memory distortions at time 2. For example, individuals can know at time 1 that they are imagining an event and later, at time 2, believe they saw it, perhaps because the information regarding cognitive operations decays or other information becomes more salient (e.g., Durso & Johnson, 1980; Garry, Manning, Loftus, & Sherman, 1996; Goff & Roediger, 1998; Johnson, Raye, Wang, & Taylor, 1979; for evidence regarding the deleterious effects of explicit imagery instructions on eyewitness memory, see Zaragoza, Mitchell, & Drivdahl, 1997). The likelihood of such errors should increase with the ease of imagining (Dobson & Markham, 1993; Finke et al., 1988; see also Johnson et al., 1979). Findings such as these support the SMF assertion that memories are made up of collections of features (semantic and perceptual detail, cognitive operations, etc.) and that the accessibility, availability, and diagnosticity of these features change over time.

An increasingly active area of research in the eyewitness memory domain investigates developmental changes in source monitoring accuracy. For example, consistent with other findings in the source monitoring literature (e.g., Foley, Johnson, & Raye, 1983), Ackil and Zaragoza (1995) found that although no age group is completely resistant to source misattribution errors, young children (first- and fifth-graders) have an especially difficult time with source monitoring in eyewitness situations (see Qin, Quas, Redlich, & Goodman, 1997, for a general review of suggestibility in children). Although, relative to young adults, older adults often exhibit source memory deficits in other source monitoring situations (e.g., Glisky, Polster, & Routhieaux, 1995; Henkel, Johnson, & De Leonardis, 1998; Johnson, De Leonardis, Hashtroudi, & Ferguson, 1995; Schacter, Koutstaal, Johnson, Gross, & Angell, 1997), the picture from eyewitness paradigms is not clear. There is evidence to suggest both that older adults may be more suggestible than younger adults (e.g., Cohen & Faulkner, 1989) and that they may be no more suggestible than younger adults (e.g., Coxon & Valentine, 1997). The effects of aging on suggestibility thus remains an important issue in need of empirical attention.

Finally, we might note that the SMF is also useful for understanding other eyewitness suggestibility phenomena. As one example consider the case of *unconscious transference*, an eyewitness misidentification effect in which people identify in a lineup a previously viewed, but innocent, person (e.g., a bystander or someone seen in a mugshot; see Ross, Ceci, Dunning, & Toglia, 1994, for a review). From the SMF perspective, these errors are also likely source errors; the memory of the innocent person, acquired from the previous viewing, is misattributed to the criminal event (see, for example, Read, Tollestrup, Hammersley, McFadzen, & Christensen, 1990, for discussion of this and other possible factors).

As the empirical work discussed thus far illustrates, the SMF is a fruitful approach for systematically investigating both accurate and inaccurate memory. At the same time, several new lines of research have focused on refining some aspects of the source monitoring approach and on expanding its scope.

New Directions

Measuring Source Accuracy

Several groups of researchers have been working on better ways to measure source memory and on developing mathematical models of recognition and source monitoring processes.

Batchelder, Riefer, and colleagues have advanced a multinomial processing tree (MPT) approach that attempts to disentangle indices of old/new recognition (item detection) and source identification (discrimination) from various response biases likely to be operating in source identification tasks (e.g., Batchelder & Riefer, 1990). Additional efforts have been directed at improving the MPT approach to resolve ambiguities between memory and bias parameters and to extend the approach to multiple sources (e.g., Batchelder, Riefer, & Hu, 1994; Riefer, Hu, & Batchelder, 1994). The MPT approach has been criticized for simplifying high-threshold assumptions (e.g., Kinchla, 1994), and Batchelder et al. (1994) have proposed a low-threshold alternative and Bayen, Murnane, and Erdfelder (1996) have proposed a two-high-threshold alternative.

Jacoby and colleagues' process dissociation procedure also provides an approach to examining source memory. It employs two tasks that require source discriminations—an old/new recognition task (inclusion) and a source identification task (exclusion; see Kelley & Jacoby, chapter 14). The procedure is designed to generate estimates of "familiarity" and "recollection." Recollection allows one to discriminate familiar but nontarget items (e.g., list 1) from familiar, target items (e.g., list 2) in an "exclusion" recognition test that requires *yes* responses to list 2 old items and *no* to list 1 and new items. Process dissociation parameters for familiarity and recollection are similar to MPT parameters for item detection and source discrimination, and Buchner and colleagues have developed an MPT extension of the process dissociation procedure (Buchner, Erdfelder, & Vaterrodt-Plunnecke, 1995; see also the commentaries on this topic in *Consciousness & Cognition, 5(4)*).

Some researchers have proposed that signal-detection theory (SDT) models of the sort often used for recognition memory can account for source identification as well (e.g., Hoffman, 1997). Yonelinas (1994) combined an SDT approach with Jacoby's process dissociation procedure, proposing that familiarity is a signal-detection process (corresponding to d') whereas, as in Jacoby's procedure, recollection reflects a discrete retrieval process (i.e., with a threshold below which there is no recollection). Such a hybrid model is similar to earlier recognition models (e.g., Atkinson & Juola, 1974).

All of these techniques can help us extract systematic patterns from data, and each might be appropriate under some particular circumstances. However, as general theoretical models the process dissociation procedure and MPT approaches present an overly simplified way of thinking about memory because both imply that memories fall into discrete categories (e.g., familiar, recollected; detected, discriminated). In contrast, according to the SMF, the phenomenal experience of remembering can have intermediate qualities; neither familiarity nor recollection are discrete states. In addition, Dodson and Johnson (1996) have questioned the theoretical interpretation of the process dissociation procedure for not conceptually distinguishing between decisions based on phenomenal qualities (familiarity or specific detail) and processes by which those qualities arise (automatic vs controlled). For example, although familiarity may typically arise more quickly and automatically than specific detail, under some circumstances specific detail might arise quickly and automatically and under some familiarity might be used in a controlled way. Finally, SDT models have the advantage that they allow variations in amount of information relevant to judgments, but are limited in that they treat all information as falling on a single dimension. In contrast, the SMF emphasizes the multiple facets or features of memory, that features are not all equally diagnostic for any particular source attribution, that features are given flexible weights, and that decision thresholds vary depending on motives and circumstances.

Two recent developments are particularly interesting with respect to these issues. Consider variations in source information. For example, a participant might not remember which of four speakers said a word, but remember that it was one of the male speakers. Dodson et al. (1998) have proposed an extension of the MPT approach to estimate partial source information. A means for simplifying analyses involving multiple feature dimensions opens up the possibility of systematically studying the joint impact of memory characteristics in more complex situations (e.g., Bayen & Murnane, 1996; Johnson et al., 1995; Lindsay et al., 1991). The other development is an extension of signal detection methods to a multidimensional representation (Banks, Chen, & Prull, in press). This model is most consistent with the original descriptive theoretical framework proposed by Johnson and Raye (1981). It may provide an approach for systematically studying the effects of assigning differential feature weights.

In general, the increased attention to problems in measurement and to developing tractable formal models that address both more general (old/new recognition) and more specific source memory should further sharpen theoretical issues and help clarify our understanding of source attributions—both accurate and inaccurate.

Subjective Measures of Qualitative Characteristics of Memories

Understanding the qualitative characteristics that go into the phenomenal experience of remembering is of central interest in the SMF (e.g., Johnson et al., 1988; Suengas & Johnson, 1988). One way to measure the qualitative characteristics of people's memory is to ask them to discriminate between stimuli. Under the appropriate conditions (e.g., if asked which of two previously presented stimuli was red), accurate performance requires that the target characteristic is represented in memory. Such discrimination tasks have been used regularly to assess qualitative characteristics of memory (e.g., color, location, voice), and most of the studies discussed in previous sections are variations on this theme. Another way to assess memory characteristics is to score recall protocols not just for whether an event is remembered but for qualitative characteristics pertaining to how it is remembered (e.g., Brewer, 1988; Hashtroudi et al., 1990; Johnson, O'Connor, & Cantor, 1997).

Yet another way to assess people's memory for specific qualitative characteristics is to ask them for subjective reports. There has been a recent renewal of interest in such subjective measures (e.g., Brewer, 1988; Gardiner, chapter 15; Johnson et al., 1988; Tulving, 1985). For example, the remember/know paradigm asks people whether they are "recollecting" an event (i.e., they can remember specific memorial information such as color or temporal information) or only "know" that an event occurred in the past (i.e., they cannot remember specific information) (see Gardiner, chapter 15; Rajaram & Roediger, 1997, for reviews). Though useful, this procedure does not capture the nuances of subjective experience, and Gardiner and colleagues have begun asking participants about the basis for their memory decisions (e.g., Gardiner, Ramponi, & Richardson-Klavehn, 1998). These protocols can then be scored for specific characteristics (see also Johnson et al., 1988; Johnson, Bush, & Mitchell, 1998).

More specific information is also obtained by using a Memory Characteristics Questionnaire (e.g., Johnson et al., 1988). Such questionnaires ask people to rate their phenomenal experience of both general memorial characteristics (e.g., "My memory for this event is: 1 = dim to 7 = sharp/clear") and/or more specific attributes in several categories such as perceptual detail (e.g., "My memory for this event involves smell: 1 = little or none to 7 = a lot"), temporal information (e.g., "My memory for the time when the event takes place is: 1 = vague to 7 = clear/distinct"), associated or supporting information (e.g., "I remember events relating to this memory that took place in advance of the event: 1 = not at all to 7 = yes, clearly"), and so on.

There is a fairly substantial body of research showing that people's subjective reports about their memory are sensitive to various manipulations and that memories from various sources differ in their qualitative characteristics (see, for example, Gardiner, chapter 15; Johnson et al., 1993; Rajaram & Roediger, 1997, for reviews). For example, sensory-perceptual and temporal information play a central role in autobiographical memory (e.g., Conway, 1992), and confidence in autobiographical memories increases with the amount of visual information recalled (Brewer, 1988). Consistent with this, Memory Characteristics Questionnaire ratings are typically higher for perceived than for imagined events (e.g., Suengas & Johnson, 1988; McGinnis & Roberts, 1996) and higher for memories of recent autobiographical events than for memories of older autobiographical events (i.e., those from childhood; e.g., Johnson et al., 1988). Other studies confirm that memory errors are associated with misattributing specific qualitative characteristics (e.g., voice) to a particular (in this case erroneous) source (e.g., Mather, Henkel, & Johnson, 1997). Importantly, studies also show that illusory and veridical memories differ in rated memory characteristics (e.g., Conway, Collins, Gathercole, & Anderson, 1996; Mather et al., 1997; Norman & Schacter, 1997; see, e.g., Schacter et al., 1996, for relevant neurophysiological evidence). Such characteristics may not be used, and sufficiently thorough evaluative processes may not be engaged, under all circumstances (e.g., when source identification is not an explicit focus of the task, Jacoby et al., 1989; Lindsay & Johnson, 1989; Raye, Johnson, & Taylor, 1980;

see, Johnson, Kounios, & Nolde, 1996; Johnson, Nolde et al., 1997, for evidence that brain activity, and presumably the basis on which participants make source decisions, varies with encoding and test conditions), but people can often be more accurate in their remembering under circumstances that induce them to engage in more careful evaluation of available source-specifying information (e.g., Mather et al., 1997; Multhaup, 1995; Multhaup et al., 1999). Thus, it seems likely that continued systematic investigation of the qualitative characteristics of memory, and the phenomenal experiences they engender, will inform our understanding of both accurate and inaccurate memory.

Inducing Autobiographical Memories

Recent studies have established that some adults (approximately 25% in any given study) can be led to form (false) autobiographical memories for complex events from their childhood that never occurred—for example, that they spilled punch at a wedding (e.g., Hyman & Pentland, 1996; Loftus & Pickrell, 1995; but see Pezdek, Finger, & Hodge, 1997; see also, for example, Ceci, Croutteau Huffman, Smith, & Loftus, 1994 for similar demonstrations with children). The procedures used to induce false memories in these studies generally involve several of the factors that have been shown to produce source confusion when manipulated in isolation in the laboratory (e.g., imaging, repetition, high demand, lax criteria).

One particularly interesting direction for this research involves examining the relationship between individual difference factors (e.g., imaging ability, hypnotizability, dissociative tendencies) and the likelihood that false autobiographical memories can be created (see, for example, the Special Issue of *Applied Cognitive Psychology, 1998* (vol. 12): "Individual Differences and Memory Distortion"). Based on the SMF, individual differences related to any of the factors shown to affect source monitoring (e.g., vividness of images, emotional self-focus, feature weighting, the criteria adopted, availability of related knowledge) would be expected to predict the degree of source confusion exhibited. Consistent with this, Hyman and Billings (1998) found that among college students, scores on tests of dissociative tendencies (i.e., Dissociative Experiences Scale) and of imaging ability/responsiveness to suggestion (i.e., Creative Imagination Scale) were positively correlated with false memory creation (see also Winograd, Peluso, & Glover, 1998). However, other factors, such as social desirability, did not appear to be related to the rate of false memory creation in this study. Although more work is needed, this line of inquiry will help to connect our understanding of the underlying mechanisms of source confusion derived from laboratory studies with individual differences that affect susceptibility to false autobiographical memory creation.

Interpersonal Reality Monitoring

Another promising line of research investigates the processes by which we judge the sources of other people's memories—*interpersonal reality monitoring* (e.g., Johnson et al., 1998; Keogh & Markham, 1998; Schooler, Gerhard, & Loftus, 1986). Results of a recent study showed that the judgment context (in this case, whether participants made judgments regarding the veracity of other people's memory accounts under high- or low-suspicion orienting conditions) influenced the weights that participants assigned to perceptual and emotional detail and the mix of heuristic and systematic processes engaged while making the judgments (Johnson et al., 1998). These data confirm that interpersonal reality monitoring can be understood in terms of basic SMF principles. Moreover, in addition to clarifying how it is we go about assessing the veridicality of others' memories, these experiments suggest questions about interpersonal reality monitoring in several applied domains, especially those in which professionals must evaluate the veracity of people's accounts of past events.

For example, *statement reality analysis* (or *statement validity analysis*) is a framework employed in German and Swedish courtrooms to expertly evaluate witness credibility. This approach exemplifies the basic tenets of the SMF: individuals engaged in statement reality analysis weigh characteristics of the information reported, such as the quantity and vividness of emotional and perceptual detail, taken together with their knowledge and beliefs about situational and motivational factors (e.g. Steller, 1989; Undeutsch, 1989). Sporer (1997) recently compared forensic assessment of the contents of witnesses' reports, known as criterion-based content analysis, and reality moni-

toring criteria (e.g., Johnson & Raye, 1981) and found that training with reality monitoring criteria allowed participant judges to rate the veracity of "witnesses'" accounts at greater than chance levels and slightly better than with the criterion-based content analysis criteria (although there are interpretive difficulties with the findings regarding relative accuracy with the two sets of criteria). Nevertheless, while there is empirical support for the underlying assumptions of the statement validity analysis/criterion-based content analysis approach (e.g., on average, true memories have more perceptual detail than false memories), empirical work on source monitoring also suggests caution in drawing firm conclusions about any particular memory (Johnson et al., 1993).

Cases of alleged recovered repressed memories of childhood sexual abuse especially highlight the need to understand interpersonal reality monitoring.[2] Putting aside the controversial issue of whether or not assessing the historical truth of a memory is clinically beneficial, each court case involving recovered memory experiences illustrates the importance of accurate assessment of the veracity of these accounts, not only by clients but also by their families, therapists, judges, and juries. Given what we know about source monitoring more generally, it seems likely that people involved in these cases may sometimes make this assessment with overconfidence—that is, without sufficient understanding of either intra-individual or interpersonal reality monitoring processes (e.g., the impact of imagination, lax source monitoring criteria; e.g., Lindsay & Read, 1994). Furthermore, it seems likely that the desire to believe the past was a certain way, or to find a cause for one's own (or one's client's) distress, might alter the assumed diagnosticity of some memory characteristics—for both clients and therapists. For example, people may minimize perceptual details and/or put extra trust in affective content when judging whether a memory is veridical under such circumstances (see Johnson et al., 1998, for evidence that weights assigned to different attributes may depend on people's prior assumptions). Thus, interpersonal reality monitoring among memory-exploring professionals may itself serve as a fruitful focus of scientific inquiry.

Empirical work is just beginning to investigate the processes used by memory-exploring professionals, and the effectiveness of their ability to monitor the veracity of other people's memories of past events (e.g., Sporer, 1997; Ceci et al., 1994). Nevertheless, progress is being made both in communicating theoretical ideas and empirical results from laboratory studies to memory-exploring professionals and in communicating to experimental psychologists the practical issues that these professionals face with regard to interpersonal reality monitoring (e.g., Belli & Loftus, 1994; Lindsay, in press; Lindsay & Briere, 1997; Lindsay & Read, 1995; Read & Lindsay, 1997).

Knowledge, Beliefs, and Stereotypes

Most of our discussion thus far has centered on source monitoring as it applies to episodic memory. However, recent research confirms that the SMF can also be applied to stereotypes, attitudes, beliefs, and other forms of "nonepisodic" knowledge. For example, Mather, Johnson, and De Leonardis (1999) demonstrated the impact of stereotypes on the accuracy of source memory (see also Sherman & Bessenoff, 1999). This study showed that while both younger and older adults were better at remembering the source of stereotypically consistent information (i.e., they could more accurately attribute statements to speakers if the statements were consistent with the speakers' assigned political affiliation than if they were inconsistent), older adults were at a disproportionate disadvantage when information was inconsistent with an established stereotype. In addition, this study showed that people may be somewhat more prone to the deleterious effects of stereotype-induction when something (in this case focusing on their feelings) keeps them from fully encoding source-specifying information that could be used later for accurate source discrimination (see also Hashtroudi et al., 1994; Johnson et al., 1996). Other research has investigated the role of source monitoring in producing and sustaining stereotypes (e.g., Banaji & Greenwald, 1995; Slusher & Anderson, 1987). It seems reasonable that the SMF can provide a fertile avenue for future investigations of not only stereotypes but also attitudes, beliefs, and other phenomena that typically have been investigated within the domain of social cognition (e.g., Wilson & Brekke, 1994).

Brain Mechanisms

Based on neuropsychological studies of brain-damaged patients, it appears that two regions

are particularly critical for source memory. Lesions in medial-temporal or diencephalic areas disrupt the feature binding processes required for encoding and consolidating complex memories (e.g., Squire & Knowlton, 1995) and lesions in the frontal regions disrupt self-initiated processes that promote binding (e.g., through maintaining activation) and that are often critical for retrieval and evaluation (e.g., Stuss & Benson, 1986). Consistent with this pattern, relative to younger adults, older adults show source memory deficits that are related to their performance on neuropsychological tests of medial-temporal and frontal function (Craik, Morris, Morris, & Loewen, 1990; Glisky et al., 1995; Henkel et al., 1998; Schacter, Koutstaal, & Norman, 1997). Frontal damage often results in deficits on source identification tasks (e.g., Schacter, Harbluk, & McLachlan, 1984; Shimamura & Squire, 1987) and, especially combined with damage to certain other areas (e.g., basal forebrain), sometimes results in profound source confusions called confabulations (e.g., DeLuca & Cicerone, 1991; Johnson, Hayes, D'Esposito & Raye, in press). Theories of confabulation (e.g., Baddeley & Wilson, 1986; Burgess & Shallice, 1996; Johnson, 1991; Moscovitch, 1995) converge on the factors outlined in the SMF, although with varying degrees of emphasis on specific aspects (Johnson & Raye, 1998). Furthermore, in a recent discussion of memory distortion from a cognitive neuroscience perspective, Schacter, Norman, and Koutstaal (1998) adopted a general theoretical position similar to the SMF. More specific links between neural mechanisms and the theoretical ideas embodied in the SMF (e.g., Johnson, Hayes et al., in press) await more systematic studies designed to explore source monitoring using measures of cortical activity—such work is just now beginning.

Recent studies using electrophysiological (ERP; e.g., Johnson, Kounios, & Nolde, 1996; Wilding & Rugg, 1996) and neuroimaging (fMRI; e.g., Nolde, Johnson, & D'Esposito, 1998; Nyberg et al., 1996; Zorrilla, Aguirre, Zarahn, Cannon, & D'Esposito, 1996) techniques to examine the cortical activity of healthy young adults engaged in source monitoring tasks have found activation in both right and left prefrontal cortex. Furthermore, a review of studies that collected neuroimaging data during episodic memory tests suggests that relatively simple episodic remembering engages right prefrontal cortex and more reflectively demanding episodic remembering engages left prefrontal cortex as well (Nolde, Johnson, & Raye, 1998). Taken together, these results suggest the Cortical Asymmetry of Reflective Activity (CARA) hypothesis. CARA is the working hypothesis that heuristic source monitoring processes may be supported by right prefrontal cortex and systematic processes by left (or left and right) prefrontal cortex (Johnson & Raye, 1998; Nolde et al., 1998). CARA remains to be cashed-out; specifying the component processes (e.g., Johnson, 1997) involved in heuristic and systematic mental activities, and how they interact with various attributes of memories such as visual information, cognitive operations, and emotional detail, is one of the challenges ahead.

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Notes

1. While other types of source errors are obviously possible (e.g., witnesses might come to remember that something they did see was only suggested to them later), evidence suggests that these types of errors are more rare (Belli, Lindsay, Gales, & McCarthy, 1994; Zaragoza & Lane, 1994). For other examples of cross-modality source monitoring errors see, for example, Henkel, Franklin, and Johnson, 1999; Intraub and Hoffman, 1992.

2. Thorough reviews of the psycho-socio-legal phenomenon of alleged recovered repressed memories of childhood abuse, and the relevant empirical findings, are available elsewhere (e.g., the special issues of *Applied Cognitive Psychology, 8* (1994); *Consciousness and Cognition, 4* (1994); *Current Directions in Psychological Science, 6(3)* (1997); see also, for example, Conway, 1997; Lindsay & Read, 1994, 1995; Loftus, 1997; Read & Lindsay, 1997).

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