Psychological Review
1981, Vol. 88, No. 1, 67-85

0033-295X/81/8801-0067$00.75

Reality Monitoring

Marcia K. Johnson
State University of New York at Stony Brook

Carol L. Raye
Barnard College

People remember information from two basic sources: that derived from external sources (obtained through perceptual processes) and that generated by internal processes such as reasoning, imagination, and thought. Of particular interest to us are the processes people use in deciding whether information initially had an external or an internal source, which we call "reality monitoring." We propose a working model of reality monitoring to account for both discrimination and confusion between memories for thoughts and memories for perceptions. Examples of questions the model addresses are, What types of information are more likely to be represented in memories of external events than in memories of internal events? What cues allow people to decide the origin of a memory? What is the nature of the decision processes involved? Which processes, and under what conditions, are likely to break down and lead to unreliable memory? What assumptions do individuals have about their memory for their thoughts compared to their memory for their perceptions? How accurate are these assumptions? We summarize some research that is encouraging as far as the tractability of some of these problems is concerned and that demonstrates the usefulness of the particular working model proposed here.

Both perception of external stimuli and thought produce memories. We have referred to the processes by which a person attributes a memory to an external or an internal source as *reality monitoring* (Johnson, 1977; Johnson & Raye, Note 1). Of course, in one sense, the memories created by thoughts are no less "real" than those created by perceptual experiences, and the former can be shown to have important consequences; for example, thinking about something may make it seem as though it was perceived more often than it actually was (e.g., Johnson, Taylor, & Raye, 1977). However, *real* commonly refers to things existing outside of oneself, and it is this sense that is implied by reality monitoring. The term is intended to suggest similarities with the concepts of reality testing and memory monitoring. Reality testing generally refers to the process of distinguishing a present perception from a present act of imagination or act of remembering (Cameron, 1963; Freud, 1895/1966, p. 325, 1925/1961, p. 237; Horowitz, 1978).

Reality testing has received some experimental attention from investigators interested in perception (Perky, 1910; Segal & Fusella, 1970) and from those interested in clinical problems, especially because of the central role confusion between the real and the imagined plays in diagnoses of schizophrenia (McGuigan, 1966; Mellor, 1970; Mintz & Alpert, 1972). In contrast, reality monitoring refers to the process of distinguishing a *past* perception from a *past* act of imagination, both of which resulted in memories. Reality monitoring thus also shares with Hart's (1967) memory monitoring concept the idea of making judgments

This research was supported by Grant BNS-7813054 from the National Science Foundation. We would like to thank Mark Aronoff, Ed Casey, Don Fry, Julie Hochberg, Emil Menzel, and Tom Taylor for their participation in discussions that clarified some of the ideas in this article and for their helpful comments on an earlier draft of the manuscript.

The general issue addressed here was raised at the annual meeting of the American Psychological Association, Chicago, 1975. The proposed model and some of the present data were initially presented at the annual meeting of the Psychonomic Society, San Antonio, Texas, 1978, and at the annual meeting of the Rocky Mountain Psychological Association, Las Vegas, Nevada, 1979.

Carol Raye is now at Bell Telephone Laboratories, Piscataway, New Jersey 08854.

Requests for reprints should be sent to Marcia K. Johnson, Department of Psychology, State University of New York, Stony Brook, New York 11794.

about information in memory. Reality monitoring is particularly interesting in that fairly extreme errors about the origin of memories are probably more common than reality testing failures such as hallucinations. Reality monitoring failures may also generally be more difficult to correct than misperceptions. You cannot, for example, move your head to look for changes in occlusion or reach out and try to touch an erroneous memory.

One way to regard the events we call failures in reality monitoring is as the extreme consequences of elaborative processes that have consistently interested cognitive psychologists. Cognitive approaches to memory emphasize memories as a joint product of external and internal events (e.g., Bartlett, 1932; Bruner, 1957; James, 1890/1950; Krech, 1949; Köhler, 1947/1959; Lashley, 1967; Postman, 1951; Tolman, 1948; and, more recently, Bower, 1972a; Bransford & Johnson, 1973; Cofer, 1973; Craik & Lockhart, 1972; Dooling & Lachman, 1971; Hochberg, 1979; Kintsch, 1976; Mandler, 1967; Neisser, 1967; Paivio, 1969; Tulving, 1968). With rare exceptions (e.g., Gibson, 1966, 1979), few modern investigators propose that there is a straightforward relationship between physical stimuli and the mind's impression of those stimuli, much less our memory for them. Rather, the more general view is that most, if not all, stimuli are subject to alternative interpretations and elaboration and that what is remembered is based on the way that events are interpreted, organized, and thought about. Given this theoretical framework, is there any reason to make a distinction between memories of perceptions and memories of thoughts?

The idea that there can be no memories of pure sensory experience without some degree of cognitive elaboration is certainly compelling. Yet equally compelling is the idea that memories do vary in the extent to which they are tied to external events (i.e., publicly available stimulus conditions). In ordinary usage, memory is by definition distinguished from imagination by virtue of its veridicality. Furthermore, the importance of the distinction between externally and internally generated information is not simply definitional. For example, memories of childhood experiences such as sexual encounters may suggest different psychological constructs depending on whether they represent early imaginative processes or actual perceptual experiences. Freud's decision to treat such memories as largely the product of fantasy greatly influenced the development of psychoanalytic theory, especially of the idea of infantile sexuality (Heidbreder, 1933, pp. 385–386). In short, the fact that the criteria of veridicality may not be entirely clear to memory theorists does not argue against the central role veridicality plays in the concept of memory.

Our position is not really in conflict with a general cognitive view emphasizing the contribution of thought to comprehension and memory (e.g., Bransford & Johnson, 1972, 1973). However, in attempting to demonstrate that people do think while perceiving and remembering, there has been a tendency to overemphasize the hopeless entanglement of memories derived from perception and thought. Many investigators have assumed not only that a memory is a joint product of the external and internal events but also that this joint memory exists in place of what might be called the external and the internal components. For example, "We have strong evidence that the list-as-presented is not the list-as-encoded, just as a CVC presented may *not* lead to a CVC stored, but to an NLM [natural language mediator] *instead*" (Klatzky, 1980, p. 222, emphasis added). The notions that externally generated information is discarded once it is used to generate a construction (Sachs, 1967) or that externally and internally generated traces are equivalent in every respect have led to a number of expectations—for example, that ideas and their paraphrases should be indistinguishable (Bransford & Franks, 1971; Jenkins, 1974), that both perceived and inferred components of a mental map should be equally available (e.g., Levine & Jankovic, Note 2), and that if inferences do not intrude in recall, they must not have been made previously (e.g., Corbett & Dosher, 1978).

Thus, cognitive theorizing has sometimes assumed that the inability to disentangle internally and externally generated information is the defining characteristic of a "cognitive" system. However, it is not logically necessary to prove that specific memory (i.e., memory faithful to perceptual events) does not exist in order to show that organized mental representations do exist. Yet it is precisely the tendency to equate evidence for constructive or imaginative processes with evidence against accurate memory (and vice versa) that limits the questions cognitive psychologists have posed. In addition, in emphasizing the many transformations a stimulus might undergo, we run the danger of forgetting the dire functional implications of a memory system that is assumed to be so loosely tied to external events (although the problem is beginning to be recognized; Neisser, 1976).

If thought is assumed to produce memory representations but not necessarily to supplant those yielded by perception, a different set of questions for research is suggested. What are the characteristics of both memories derived primarily from perceptual experience and memories more remotely related to perceptual experience? How are the representations of externally and internally generated events distinguished, and when and why are they confused? Understanding the differences and similarities in the nature of internally and externally generated memories is important for any theory of the way information is represented in memory, and an adequate model must be able to account for both confusion and discrimination between past imaginations and past perceptions (Johnson, Note 3). J. S. Mill (1869/1967) suggested that "the only difficulty about Memory, when once the laws of Association are understood, is the difference between it and imagination" (p. 339). To paraphrase this notion to fit the present problem, once we have acknowledged the role of imagination in memory, we still have the problem of accounting for the conditions under which we know the difference between memories of external events and memories of imaginations. What are our "cues to reality?"

For the most part, philosophers and psychologists have not been concerned with the problem of reality monitoring, although James Mill (1829/1967) did assert that because sensations and ideas "are distinguishable in the having, it is likely that the copy of the sensation should be distinguishable from the revival of the idea" (p. 334). Although little attention has been given to the issue of discriminating memories produced by perceptions from those produced by thought, a number of philosophers have addressed the issue of how sensations and ideas are distinguishable initially ("in the having"). Two general lines of thought have been that perception and imagination primarily differ in that percepts are stronger or more vivid (e.g., Hume, 1739/1978; James, 1890/1950) and the opposing idea that "sensation . . . and imagination, even where they have the same object, are operations of a quite different nature, and perfectly distinguishable by those who are sound and sober" (Reid, 1764/1975, chap. 2, section 5, p. 18). The model presented below incorporates aspects of both of these hypotheses and further suggests that some of the same cues that allow judgments about the nature (present perception or present imagination) of conscious experience are preserved and become the bases for judgments about the nature of past experience.

The Present Approach

Some Preliminary Assumptions

Although we assume that perceptual events produce persistent memory traces (perhaps in a kind of continuous record of experience; Landauer, 1975), we also assume that internally generated events produce persistent memory traces. Not all, but many of the errors we see in memory may be the consequence of a failure to discriminate the origin of a memory trace. The ideas that memory traces for perceptual experiences are accurate, in that they reflect the characteristics of stimulus-determined processes and that they exist side by side or intertwined with memories produced by imaginative processes have particular implications for theories of representation that are based on error data such as false recognitions. Insofar as false recognitions reflect a failure to discriminate the origin of a trace, their appropriateness as an indication of the nature of the memory representation of external events is somewhat questionable. That is, errors may reflect coexistence of information from multiple sources as well as integration, and this distinction is beginning to be investigated (e.g., Cole & Loftus, 1979; Hasher & Griffin, 1978). Although this argument may at first seem to be quibbling over terminology, these two metaphors certainly imply different directions for research. They might also lead to different expectations about the potential success of introspective effort (and more extreme measures such as hypnosis) in separating the real from the imagined.

Types of Self-Generated Information

There are many types of thoughts and imaginal events that would be relevant for reality monitoring. These types can tentatively be separated into three major categories: (a) re-representation, (b) cotemporal thoughts, and (c) fantasy. The first category refers to the re-representation of perceptual experience or remembering something previously experienced. In re-representation, information that has dropped out of consciousness or working memory is reactivated at a later time in the absence of the original external stimulus (in contrast to, for example, rehearsing recently perceived information several times in succession). Cotemporal thought refers to the sort of elaborative and associative processes that augment, bridge, or embellish ongoing perceptual experience but that are not neccessarily part of the veridical representation of perceptual experience. Most work on imaginal processes in memory has been directed at this category (e.g., Bartlett, 1932; Bower, 1972b; Neisser, 1967). Fantasy involves novel combinations of information that produce imaginary events that take place only in our imagination. Making up a story or dreaming would fall primarily in this category. While recognizing that there are some problems with this classification scheme (where does "re-representation" end and "fantasy" begin?), we have found it useful as a starting point. To date, our research has primarily consisted of laboratory investigations of the first two categories.

As stated above, we use the term *reality monitoring* as a way of referring to the activity of discriminating between memories primarily derived from external events and those primarily derived from internal events. However, this term is not meant to imply that the processes involved in discriminating the origin (internal or external) of information in memory are always the same. Rather, the details of the processing (activating information, applying decision strategies) might reasonably be expected to vary depending on the nature of the remembered information, the conditions under which the monitoring occurs, the cost of mistakes, and so forth. Finally, reality monitoring can be thought of as one of the general class of metamemory processes (e.g., see Brown, 1975; Kreutzer, Leonard, & Flavell, 1975) by which people reflect varying degrees of understanding about the nature of their own memories.

A Working Model

As a vehicle for interpreting available data and as a stimulus for further research, we have developed the following working model of reality monitoring. Basically, we propose that reality monitoring is affected by two major factors: the nature of the traces being evaluated and the types of decision processes applied. Either of these should influence the amount of confusion a person displays about the origin of information. Our first assumption is that any memory potentially consists of many types of information or attributes (e.g., Bower, 1967; Craik & Lockhart, 1972; Posner & Warren, 1972; Underwood, 1969; Wickens, 1970). Thus, for example, if a word is presented or imagined, information may be stored with respect to its physical properties (e.g., pitch) and its semantic properties. Types of potential attributes that should be particularly important for reality monitoring include information about the sensory characteristics of the stimulus presentation (e.g., auditory information), the type of cognitive processing engaged (e.g., imagery), semantic content, and contextual information (e.g., spatial and temporal information). Various subcategories could be defined within each of these four. For example, semantic content for a spoken word, as used here, would include physical aspects of its referent such as size and color, functional characteristics of the referent, emotional connotation, and so on. An issue that could plague us, as well as most recent theories of memory based on "attributes," "levels," or "codes" (e.g., Craik & Lockhart, 1972; Paivio, 1971; Underwood, 1969), is, How is it possible to separate sensory from semantic dimensions of memory representations? The fact that something is seen and not heard (or said by a low frequency voice rather than a voice higher in frequency) might have significance in the semantic sense, as might the spatial or temporal position of an event. These categories are not necessarily proposed as hard and fast divisions (any more than one can make a clear distinction between internal and external) but represent sensible and useful analytic categories for characterizing and understanding the nature of information represented in memory.

We propose that, as a class, internally generated memories may differ from the class of externally generated memories along specific dimensions. First, externally generated memories in general may have more spatial and temporal contextual attributes coded in the representation of the event than internally generated memories do. Second, they should also have more sensory attributes, although imaginal processes presumably also generate some sensory information (e.g., see Atwood, 1971; Brooks, 1968; Finke, 1979; Kosslyn, 1976). Third, we propose that externally generated representations are more semantically detailed—that is, contain more information or more specific information—than internally generated representations. Thought tends to be more schematic. Finally, we propose that internally generated memories may typically have more operational attributes associated with them (coded in the trace). This latter notion is based partly on the assumption that perception is usually somewhat more "automatic" (Brown, 1975; Hasher & Zacks, 1979; Posner & Snyder, 1975) than imaginal processes and that attention (e.g., voluntarily engaging in creating images) increases the chances that coded information about operations will be available later (see Posner & Warren, 1972).

Although for some cases these characteristics might not hold, if the two classes of representations generally differ in these ways, then these dimensions could be used to decide the origin of a trace regardless of the particular content of the memory involved. Assuming that the populations of external and internal memories form distributions on each of these four dimensions, a reasonable model of the process involved in decisions about the origin (internal or external) of a memory might be similar to some models of old–new recognition decisions (e.g., Atkinson & Juola, 1973; Mandler, 1972; Raye, 1976). That is, criteria may be set on each dimension, one for identifying probable internal events and one for probable external events, and any event registering between the two cutoffs would be of uncertain origin and require further processing. Figure 1 illustrates such a decision structure for one of the proposed dimensions.

Information about these four dimensions could of course be combined in different ways. Decisions could be based on a strategy that always or usually weighted the four in a constant fashion, for example, sensory attributes might always be weighted more heavily than amount of detail, and amount of detail more heavily than contextual attributes, and so on. On the other hand, different dimensions might be given more weight in varying instances depending on what other information the individual has about the situation. In general, then, it should be possible to produce confusion

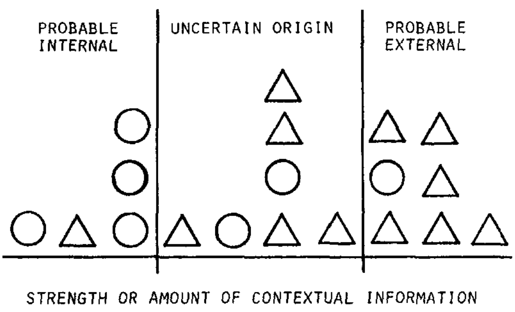

Figure 1. Representation of a set of decision rules for judging the origin of a memory on the basis of the amount of contextual (time and place) information it includes. (In this sample, externally derived memories are represented by triangles and internally derived ones by circles.)

about the origin of an event by manipulations that cause it to have abnormally high or low values on one or more dimensions, compared to typical memories of its class; an interesting question is whether some dimensions are more important in this regard than others.

In addition to atypical class characteristics, a major vehicle for confusion should be specific similarity (with respect to any attribute) between particular memories from the two classes. We have discussed "a memory" as if it could be isolated, but this is just for convenience. Clearly, when a memory is activated, so are other memories, and the characteristics of these other memories may influence or dominate the decision process. Thus in considering the origin of a memory that was actually generated internally, one might be influenced by extensive sensory characteristics of semantically similar traces that are also activated while the target is being evaluated. The extreme case would be one in which a retrieval cue activates a similar trace from the opposite class but not the target, causing an apparent error in identification of origin when, in fact, the target trace is not being considered at all.

As mentioned earlier, decisions about the origin of a memory based on the proposed typical class differences may be inconclusive, and the person may access further information. The person then may use this further information to reason toward a decision about the origin of the memory. This further information may consist of qualitative characteristics of the trace being evaluated in combination with the person's prior knowledge. For example, a person may remember an extremely vivid dream about a money tree but reason that it could not be an externally generated memory because money does not grow on trees. Or this further information may consist of characteristics of related traces. For example, suppose an architect was not sure whether a design she had in mind was initially hers or her associate's. She then remembers not only the idea but also her associate's starting to draw a rough sketch and breaking his pencil. Therefore, she reasons, the idea must have been his.

Finally, this type of reasoning also probably uses strategies based on certain metamemory assumptions or beliefs held by the individual. For example, subjects might have certain "biases" about memories derived from their own thoughts (e.g., "I'd remember if it had been my idea"). These latter processes need not always wait for the outcome of the more general decision based on class characteristics discussed above but may be initiated simultaneously. However, since they are assumed often to involve more specific information, which may require additional retrieval from memory, they are presumed normally to take longer and for this reason might be considered a second stage. Which processes play the predominant role in a particular decision should depend on such factors as the amount of time a person has, availability of additional information in memory, and the cost of mistakes. Thus, if the consequence of asserting that something was perceived when in fact it might only have been inferred is serious, a person should be particularly likely to attempt to retrieve additional information that would tend to support or confirm one or the other decision.

In general, both perception and thought result in memories that persist. Confusion of the two does not necessarily happen via degradation of traces but rather can happen via other mechanisms.

Empirical Evidence

The model developed above (see Table 1) represents a set of interrelated hypotheses, and we have tried in a number of ways to translate some of these hypotheses into experiments.

Evidence That the Classes of Externally and Internally Generated Memories Differ

A fundamental assumption of the model is that the classes of externally and internally derived memories differ. Two lines of evidence suggest this is a reasonable starting point.

Superiority effects. Slamecka and Graf (1978) reported the results of several experiments specifically directed at determining whether there is a memory advantage for self-generated information. Their general

Table 1
Summary of the Model

Types of attributes potentially comprising memories
Contextual
Sensory
Semantic
Cognitive operations
Dimensions on which the classes of externally generated and internally generated memories typically differ
External have more contextual attributes
External have more sensory attributes
External have more semantic detail
Internal include more information about cognitive operations
Processing characteristics of reality monitoring
Decisions about the origin of a specific trace may be based on a weighted combination of the results of comparing the target trace attributes indicated above to criteria defining the general classes of external and internal representations
Decisions may be based on a reasoning process involving
Qualitative characteristics of the target trace
Characteristics of related traces
Metamemory assumptions
Which processes take place should depend on such factors as time, availability of different types of information, cost of mistakes, and so forth
Sources of errors in reality monitoring
Target trace not typical of its class
Characteristics of similar incorrect traces
Failure in a reasoning process (e.g., failure to retrieve additional information, incorrect metamemory assumptions)

procedure was to present subjects with a stimulus and either to present a response (E items) or to require the subject to generate a response (S items) according to a rule and a specified first letter. The rule and first letter constrained the generated responses (e.g., *synonym–rapid–f* almost always produced the response *fast*), allowing Slamecka and Graf to counterbalance the assignment of items to conditions such that E and S items were the same across subjects. Across a number of types of items and instructional conditions, recognition and recall were better for the subject-generated items (the "generation effect").

Using a similar procedure, we have also found a generation effect after retention intervals as long as 10 days (Johnson, Raye, Foley, & Foley, in press, Experiment 2). In addition, in one study we manipulated whether subjects overtly responded by writing down E and S words as they occurred or whether they were simply required to respond covertly by listening to E words and thinking about S words. The generation effect was as great in both free and cued recall when the subjects thought about but did not overtly express their responses (Johnson, Raye, Foley, & Foley, in press, Experiment 1). This outcome supports the idea that the locus of the advantage is in the generation process itself and does not, for example, depend on overt expression of the generated item and consequent sensory components (e.g., hearing one's own voice or seeing one's own handwriting) or on some combination of generation and sensory components.

In several studies, we compared frequency judgments of externally generated events with frequency judgments of self-generated events (Johnson, Taylor, & Raye, 1977; Raye, Johnson, & Taylor, 1980; Taylor, Johnson, Birnbaum, & Raye, Note 4). The basic paradigm involves two kinds of trials, presentation and generation. On presentation trials, subjects see a number of cues and to-be-remembered words; on generation trials, the cues are shown, and subjects are asked to generate the items. The cues are preselected so that they will elicit the appropriate response with almost 100% certainty (e.g., *color–blue*). Over the course of the procedure, each item is seen either two, five, or eight times and is generated by subjects either two, five, or eight times. Finally, subjects are given a surprise frequency judgment task. For example, they are asked to estimate the number of times they actually saw each item, and we explain to them that we are not interested in the number of times they generated it but only the number of times we presented it. Or, they are asked to indicate the number of times they generated an item, ignoring the number of times they perceived it.

These studies had two major outcomes. The first was that subjects were more sensitive to the relative frequency of self-generated events than to the relative frequency of externally generated events. The second major finding concerned confusion between the two types of events. If there were no confusion between presentations and generations, it would not matter, for example, how often an item had been generated when subjects judged how often it was presented. However, generating events systematically increased the frequency with which those events seemed to have been perceived. Similarly, perceiving items systematically increased the frequency with which those items seemed to have been generated. However, the two types of events did not interfere with each other equally. The extent to which subjects were confused by internal events when they judged external events was greater than vice versa. Thus both the steeper frequency discrimination function for self-generated information and the greater confusion in judging external events indicated that internally generated memories were superior to or had some advantage over externally generated memories in this situation, as well as in recall and recognition tests. A number of related findings also suggest there is some advantage associated with self-generated information (e.g., Bobrow & Bower, 1969; Davies, Milnee, & Glennie, 1973; Erdelyi, Buschke, & Finkelstein, 1977; Jacoby, 1978; Jarvella & Collas, 1974; Ross & Sicoly, 1979).

Another indication that external and internal memories differ comes from Raye et al. (1980, Experiment 2). Half the people judging each type of event were given a limit for their estimates—they were asked to use numbers between 0 and 10. The other half of the subjects were not given any limit or range for their estimates. We expected this manipulation to affect the criteria subjects used for including memories in an "event count." Of special interest was whether the two types of judgments would be affected similarly. If they were, it would emphasize the similarity between externally and internally derived memories. However, if the two were affected differently, the results would point to differences in the memories or judgment processes in the two cases. For example, if memories for one type of information are more stable and faithful, they might be less susceptible to variations in judgment criteria. In fact, the limit did not affect the magnitude of confusion when people were judging the frequency of internally generated events. This finding suggests that even without the limit, people were using a fairly stringent criterion of trace appropriateness. (Perhaps *specific* would be more accurate than *stringent*, since whatever they used allowed for good discrimination of relative frequency of self-generated events.) When external event frequency was judged, however, the limit reduced confusion, apparently because subjects selectively excluded more inappropriate, self-generated event memories. Thus, these two types of traces must differ in some way that allows the subject to discriminate between them. Raye et al. argued that these results were consistent with the present working model if it were assumed that when judging the frequency of internally generated events, subjects were relying heavily on the presence of information about cognitive operations in making decisions about whether to include memories in an event count (see Raye et al., 1980, for an expanded discussion).

Comparing between- and within-class discriminations. Another line of research is based on the logic that if two classes of events are different, discriminating between instances from within a class should be more difficult than discriminating between instances drawn from separate classes. For example, is reality monitoring subject to more or less error than monitoring the origins of information derived from two external sources? Our model proposes that, along with more specific information, there are a number of general dimensions on which externally and internally derived memories may characteristically differ and which may be used in the process of reality monitoring. That is, decisions could be based simply on the amount of certain types of information (e.g., if it has a high sensory component, classify it as external). In contrast, two memories derived from external sources could not be distinguished along these general dimensions. Thus memories from external sources would always have to be discriminated on the basis of specific content (specific sensory information rather than amount, etc.). It follows that, given similar situations, it should be easier to identify the origin of internally versus externally derived memories than to identify the sources of memories derived from two external sources.

In one experiment testing this prediction, subjects participated in small groups during the first phase of the experiment (Raye & Johnson, 1980). Within a group they were randomly assigned to play different roles: speakers, recorders, or listeners. All subjects thought that the speakers and recorders were serving as "experimenters," that the listeners were the "subjects," and that the listeners would later be tested for their memory of the "conversation." The group was given a topic of conversation to start them off, for example, *snow*. Speaker A then gave a highly related word such as *white*. Speaker B gave a word related to Speaker A's word, for example, *black*, then Speaker A replied, for example, *coal*, and so on, alternating. One recorder wrote down all of the words spoken by Speaker A; the other recorder wrote down all the words given by Speaker B. The listeners were instructed to listen carefully to both speakers in preparation for a memory test later. After a 1-hour, filled, retention interval, all subjects received a recognition test which had the standard requirement that subjects discriminate between old and new items and the additional requirement that, for old items, they identify which speaker said each.

The measure of primary interest was the percent correct identification of origin: the total number of words correctly attributed to each of the two speakers divided by the total number of words correctly identified as from the conversation (multiplied by 100). As predicted by the model, the speakers, who were discriminating between internal and external sources, were better at identification of origin than the listeners and recorders, who were discriminating between two external sources of information.

This result was taken as support for the idea that external events as a class differ in some ways from the class of internal events. These differences potentially provide additional cues that allow the origin of memories for internally generated events and external events to be distinguished more easily than the memories for two comparable external events. Such cues would operate in the first stage of the model. For example, greater salience of the cognitive operations that produced internally generated traces may serve as a discriminative cue available in external–internal discriminations that is not available in external–external discriminations. Another possibility is that the semantic contents of the memories differ in some way. Intuitively, internally generated responses should be more idiosyncratically determined than external events. Internally generated events are not necessarily more meaningful than external events, but they are more likely to refer to biographical information or information relevant to the self. Internal events reflect idiosyncratic probabilities, whereas external events reflect normative probabilities. The presence of a difference in average idiosyncracy value for external and internal items could provide a discriminative cue: Would I have said this? Is this a high frequency response for me? Does this response have some special meaning for me? This factor might operate in the reasoning stage of reality monitoring.

In a second conversation study (Raye & Johnson, 1980, Experiment 2), the content (as well as the idiosyncracies) of the conversation was controlled. A subject, the "director," asked the speakers questions such as, "What is a word that is the opposite of *fast*, beginning with *s* and ending with *w*?" The director indicated which of the two speakers was to answer, and the speakers' responses were essentially determined by the questions, which, obviously, left little room for idiosyncratic contributions to the content of the conversations. Again, there were recorders and listeners, and only the listeners thought they would get a memory test. All subjects, including the directors, were later given a recognition and identification-of-origin test.

Again, the speakers were significantly better at identifying the origin of an item they recognized as old than were the recorders and listeners, and the recorders and listeners did not differ from one another. The directors had the lowest discrimination scores. This finding rules out, we think, the possibility that the entire difference in the previous experiment could be attributed to differences across conditions in the idiosyncratic value of the content of the items. In fact, the magnitude of the difference was almost exactly the same as it was in the previous experiment, suggesting that idiosyncratic cues did not add much. Of course, we would not want to offer this as a general conclusion, since we would expect idiosyncratic value typically to be one of the cues used in the reasoning processes involved in reality monitoring. However, the present results are consistent with the possibility that, independently of the personal significance of what an individual says, the cognitive operations that go into generating information persist in memory and become potential cues as to the origin of that information.

A parallel logic suggests that it should be easier to discriminate between memories of external and internal events than between memories of two internally generated events because, for example, the latter would both include large amounts of cognitive operations information, minimizing cognitive operations information as a discriminative cue. In two developmental studies, Foley, Johnson, and Raye (Note 5) had subjects engage in two types of self-generated acts, either saying items aloud or only thinking about them. Subjects then attempted to identify which items they said and which they thought. Consistent with expectations from our model, this condition was more difficult than one in which the subjects discriminated between items they had said and items someone else had said.

Compared to older subjects, 6-year-old children were at no disadvantage in discriminating what they said from what someone else said (see also Johnson, Raye, Hasher, & Chromiak, 1979). In contrast, compared to older subjects, 6-year-olds did have a particularly difficult time discriminating between words they had said aloud and words they had only thought. Within the present framework, these data suggest two interesting possibilities. First, children as young as 6 years may have learned to take advantage of cues in memory that differentiate the self from others but not those that differentiate various self-initiated acts such as speech and thought. Thus the special confusion of young children could be a consequence of a less developed reasoning process and not a consequence of trace characteristics. Alternatively, 6-year-olds, compared to older subjects, may produce memories when thinking that are, in fact, more like the memories produced from talking. Similarity between thought and speech would be increased, for example, by subvocalizing during thought, and there is some evidence that children of this age do show relatively high levels of subvocalization (Garrity, 1977).

Specific Dimensions Proposed as Discriminators

Cognitive operators. According to the reality monitoring model, increasing automaticity in responding ought to reduce information regarding cognitive operations. The stronger or more specific the cue for a response, the more automatically the response should be generated, reducing search and decision processes that later could be used as cues to the origin of information. Conversely, if a response requires somewhat more effort or search, stored information about these operations should become a potential cue for identifying the source of a memory. In order to manipulate this search process, we used a procedure in which subjects heard category cues followed by category instances on half of the trials and generated their own category instances for the other half of the trials. Half of the subjects were cued with the first letter of the response, and half were not cued with the first letter. Our reasoning was that providing the first-letter cue should more completely determine the response, making it more automatic, than not providing the first letter.

Later, subjects were asked to discriminate between category instances that were presented and instances they generated. Generating instances of categories to fit first-letter cues resulted later in lower correct identification of origin than generating instances of categories without first-letter cues (Johnson, Raye, Foley, & Foley, in press, Experiment 1). In Johnson et al.'s Experiment 2, increasing the difficulty of generating a response and thus presumably increasing cognitive operations information by requiring a less typical response (e.g., *animal–p–*, rather than *animal–d–*) increased correct identification of origin. These findings support the notion that cognitive operations information is important in reality monitoring decisions.

The cue value of remembered cognitive operations may explain why mediators generated by subjects in list learning situations are rarely intruded. That is, there is ample evidence that in paired-associate learning, for example, subjects generate verbal or pictorial elaborators (e.g., Martin, Boersma, & Cox, 1965; Yuille, 1973) and that specific qualitative characteristics of these elaborators influence recall (Hasher, Griffin, & Johnson, 1977; Hasher & Johnson, 1975). In addition, self-generated information has a recall advantage (Slamecka & Graf, 1978), even when the self-generated information occurs only covertly (Johnson, Raye, Foley, & Foley, in press, Experiment 1). Why is it then that intrusions of the mediator or self-generated components of an image or other types of elaborators are so rare? From the present perspective, it is important that when subjects create verbal or imaginal elaborators, the strategy is usually purposefully employed and not the result of automatic or incidental processes (Brown, 1975; Hasher & Zacks, 1979; Posner & Snyder, 1975; Schneider & Shiffrin, 1977). The best argument for the strategic as opposed to automatic nature of elaborators is that it is quite easy to improve people's performance by instructing them to make elaborators (e.g., Bower, 1972b; Paivio, 1971).

On the other hand, those elaborations that more automatically arise on the basis of past experience, such as those involved in processing meaningful prose, should be more likely to be confused with external events. Intrusions seem to occur more often with prose. It is not that more thought necessarily goes into processing prose compared to word lists; it is perhaps that more conscious (in the sense of purposeful) thought may be expended on the word lists.

Similarly, daydreams often seem less real than dreams and rarely lead to the momentary confusion that dreams produce. Daydreams are typically more controlled by consciously selected schemata than are dreams during sleep. In general, those self-generated memories that do not have a voluntary quality but rather have been elicited by external events or generated when voluntary processes are suspended should be susceptible to greater confusion. Creating a thought under voluntary control (or bringing a previously involuntary idea under voluntary control) should provide a powerful cue for localizing it as self-generated rather than as existing externally. Consistent with this speculation is at least one finding: Whereas repeated re-representations of perceived items increase confusion (e.g., Johnson, Raye, Wang, & Taylor, 1979; Johnson, Taylor, & Raye, 1977), generating an initially self-generated item for a second time increased correct identification of origin (Johnson, Raye, & Durso, 1980).

Contextual information. In one experiment (Johnson, Raye, Foley, & Kim, Note 6), we compared the spatial location information associated with perceived pictures with the spatial location information associated with imagined pictures. Subjects saw a label followed by an appropriate line drawing projected on a screen to the left or a screen to the right, or they saw a label and then themselves created an appropriate image projected to the left or to the right. As a cover task, subjects rated the pictures and images with respect to how easy they would be to draw. This task produced equal recognition of items that had been presented as pictures and items that had been imagined (one indication of the effectiveness of this cover task). Of primary interest was the finding that, as predicted by the model, subjects were significantly more accurate in designating the location for perceived as compared to imagined items. In addition, for those items whose location was correctly designated, subjects were more confident about the location of the perceived pictures.

We adapted a similar procedure to address the question of whether temporal information is better for internally or externally generated information. Subjects heard labels and then either saw an appropriate line drawing or imagined one. The cover task was the rating task just described. Following this, each subject received a booklet, and on each page, in random order, were labels for eight items, each drawn from a different eighth of the list. The eight items either all referred to pictures or all referred to images. The subject's task was to indicate the temporal order of occurrence of the eight items. We used this procedure to eliminate differential response bias across positions of the list (Toglia & Kimble, 1976). This task turned out to be quite difficult, but the subjects were able to identify the temporal position of very early and very late items. For items presented early, performance did not differ on imagined as compared to perceived items, whereas the subjects were significantly less accurate in identifying temporal order of imagined items for the most recent portion of the list. We are currently following this up with an easier task; however, this initial finding is particularly interesting because some investigators (Bjork & Whitten, 1974; Crowder, 1976, pp. 461–464) have proposed that the recency portion of the serial position curve especially reflects the contribution of temporal information.

Sensory information. The model also predicts that sensory information should be greater for perceived compared to imagined items. In one experiment (Johnson, Raye, Foley, & Foley, Note 7), subjects saw a word that was then pronounced by a male or female experimenter or saw a word and then imagined it as pronounced by the male or female experimenter. Craik and Kirsner (1974) had previously shown significant memory for voice of perceived items, and Geiselman and Glenny (1977) had shown memory for the "voice" of an imagined item. Our interest was in comparing the information about voice for perceived and imagined items. As a cover task, subjects rated the harshness of the perceived or imagined sound.

We asked a similar question with a procedure in which subjects saw or heard items on some trials or imagined seeing or imagined hearing them on other trials. The cover task required subjects to rate the angularity of the visual display of a perceived or imagined word or the harshness of the sound of an auditorially perceived or imagined item.

Across four experiments, two requiring a discrimination between male and female voices and two between visual and auditory information, we have found a consistent, but not always significant, advantage for perceived information. We think these cover tasks very closely equated the information produced during perception and thought, primarily by restricting it to a single type of sensory information, and were thus a conservative test of the hypothesis. The subject-report data described below suggest that when semantic processing is manipulated and sensory information is left free to vary, sensory information is more frequently reported for perceived than for subject-generated items.

Of course, the model does not demand that sensory information always be better for memories created by perception than for those created by thought; it only indicates that this is the more typical case. The very capacity for some thoughts to have more sensory detail than some perceptions creates one of the conditions for confusion. Furthermore, with the right orienting task, spatial location and temporal information might be equated for imagined and perceived items. One problem for future work would be to attempt to characterize those situations in which contextual, semantic, or sensory information from imagination is likely to be unusually high, or from perception, unusually low.

For example, the amount of sensory information in an imaginary experience should vary among individuals. Good imagers, compared to poor imagers, should be more able to regenerate accurately the details of their experiences. Although it may be difficult to specify exactly the differences in the nature of the representations of good and poor imagers (Pylyshyn, 1973), a likely difference is in the amount of sensory detail that is represented in the images they create. We might then expect that good imagers would more readily confuse re-representations of experiences with similar perceptions. In one experiment (Johnson, Raye, Wang, & Taylor, 1979, Experiment 1; Johnson & Raye, Note 8), we separated subjects into groups of good and poor imagers on the basis of an imagery test. Using our re-representation paradigm, subjects saw pictures of common objects taken from children's books on presentation trials and were asked to generate images of the pictures on generation trials. On a later test of presentation frequency, the judgments of good imagers were more affected by the number of times they had imagined a picture than were the judgments of poor imagers. (Good and poor imagers did not differ in their ability to recall the set of pictures).

Although it simplifies the discussion to look at one type of information at a time, we should keep in mind that all memories include several types of information and that any reality monitoring decision is the result of processes that weight and integrate information across these dimensions. The previously discussed Raye et al. study (1980, Experiment 2), which compared frequency judgments with and without a limit, demonstrated that subjects can change the weighting given to various dimensions. Which components of memories will weigh more heavily in reality monitoring judgments may depend on the nature of the events being judged. For example, cognitive operations may be particularly important in decisions about language, especially words and/or sentences given in isolation. Sensory information may prove to be the more dominant component in decisions about the origin of visual information such as pictures.

Furthermore, that decisions are not simply made on the basis of one type of information, without regard for other attributes, is illustrated by some results reported by Durso and Johnson (1980). Subjects saw a concept represented by a word or a line drawing, and on a later recognition test (where both targets and distractors were given auditorially), the subjects were asked to indicate the original mode of presentation of the items they identified as old. The orienting task at acquisition was manipulated for different groups of subjects. Some subjects were asked to perform tasks that required that they attend to the formal properties of the word symbol (what is the last letter of the name of this concept?). Other subjects were asked to perform tasks that explicitly required that they create an image of the concept (How long would it take for an artist to make a line drawing of this concept?). And some subjects were asked to perform tasks that required them to consult semantic information regarding the referent of the concept (e.g., What is this thing used for?). The most interesting data for the present purposes are the confusions between the two modes of representations, that is, the mistaken judgments that words were presented as pictures or that pictures were presented as words. The relative frequency of these two types of confusions did not differ for either the orienting tasks involving the formal properties of words or those involving explicit imagery. However, for the semantic conditions, subjects were significantly more likely to say a word had been presented as a picture than to say a picture had been presented as a word. This finding is all the more striking because there was clearly a significant bias on false positives (calling a completely new item old) to say they were presented as words rather than as pictures. The high rate of misidentifications of words as pictures by those subjects who did semantic processing suggests they had been incidentally creating images or consulting sensory information during the orienting tasks and that they later mistook this self-generated pictorial information for externally presented pictorial information.

Memories for words created in the explicit imagery conditions should also have had considerable sensory information; however, the memories also very likely included cues indicating that the image was purposefully created. On the other hand, the incidentally created images, which had less salient cues that they were generated by cognitive operations yet which had high sensory information, should be more likely to be mistaken for externally presented pictures. Thus, here is a case where it makes sense to assume that decisions about the origin of memories took into account both sensory and cognitive operations information.

Metamemory Assumptions

An important point incorporated in the working model of reality monitoring that appears to be born out by our experiments is the idea that subjects' assumptions about how their memories work will play a critical role in decision strategies and biases operating during reality monitoring.

What subjects report. The good–poor imager study above attempted to manipulate the similarity between perceptions and re-representations of those perceptions. We have also attempted to vary the relationship between perceptions and cotemporal, self-generated information (Johnson, Raye, Foley, & Foley, in press, Experiment 3). An experimenter read a list of common, unrelated words. Subjects in the *related* condition were told to generate a word for each stimulus word that had some meaningful relationship to the stimulus word. Subjects in the *unrelated* condition were told to give a word that was not in any way related to the stimulus item. Subjects in the *first-letter* condition were told to give a word that started with the same first letter as the word they heard. Thus in the related and unrelated conditions subjects gave some attention to the meaning of each externally presented item in order to perform the task, but the internally generated product should have been different in the two cases. The related and the first-letter conditions should both produce related items, but these relationships should primarily be semantic in the related group and orthographic in the first-letter condition. All subjects wrote down both presented and generated words.

A week later, subjects received an identification-of-origin test. For those words correctly recognized as old, the mean percents correct identification of the source of an item were 62, 68, and 74, for related, first-letter, and unrelated, respectively, indicating that as cotemporal thoughts become more related to perceptual events, the likelihood of later confusing their memory representations increases. However, even though the related subjects showed the least ability to identify the origin of an item, they were still significantly above a chance score of 50%.

Following the identification-of-origin test, subjects in this study were asked to describe how they were able to identify the source of various items. Subjects tended to mention sensory cues more often with respect to experimenter-generated items ("I differentiated words which you said by remembering your pronunciation"; "I could visualize your saying it"; or "The words which the experimenter stated were remembered in her voice"). Cognitive processing, additional information, and a consideration of specific semantic content were mentioned more in conjunction with subject-generated items ("When I was very sure [about my words] I could remember I had a very specific reason for making the association. If the word [only] seemed familiar, I would say that it was the experimenter's word"; "I made the decision by knowing what my train of thought was during the exercise"; "Sometimes the words I chose went together with a certain scene, i.e., pond, cloud, tree. And when I saw the words again I tried to remember if they fit in any of the images I had").

Biases in judgments. If you ask them, many subjects expect self-generated information to have an advantage in memory (Johnson, Raye, Foley, & Foley, in press, Experiment 2). This expectation is consistent with a notable bias we found: When subjects felt that a completely new item was familiar (a false positive), they displayed a much greater willingness to attribute it to an external source than to say they generated it. We found this "it-had-to-be-you" ("I'd remember if it were me") effect with the three different instructions for generating responses described above (related, unrelated, first letter), for high and low frequency category instances and opposites (Johnson, Raye, Foley, & Foley, in press Experiment 2) and for identification of origin of words from sentences (Johnson, Raye, & Durso, 1980). The pervasiveness of this bias suggests that it is probably an important component of performance in memory tasks, contributing, perhaps, to false positives in certain recognition paradigms (e.g., Cramer, 1965; Johnson, Bransford, & Solomon, 1973; Kimble, 1968; Sulin & Dooling, 1974; Underwood, 1965) and unedited intrusions in recall (Brewer, 1977; Deese, 1959). Under some circumstances, subjects can be induced with a stricter criterion to perform in a way that more closely matches real external events (Raye et al., 1980). An investigation of the circumstances that might affect this bias could prove interesting. For example, we have recently found that alcohol intoxication reduces (but does not eliminate) this bias, reflecting perhaps people's belief that one consequence of drinking is that it diminishes one's ability to remember what one did (Taylor et al., Note 4). Of course, the bias might be completely reversed if the social desirability of having been the source of an idea were markedly increased ("I don't remember generating it, but that idea is so good it has to be mine").

Remembering Occurrence Versus Remembering Origin

Do we need a model of reality monitoring that is distinct from the theories of memory that have been proposed to account for recognition and recall in general? For example, could we simply say that "deep" processing of information leads to better memory, including better identification of origin? A strength theorist might propose that identification of origin simply requires more of the same sort of information that recall and recognition depend on. However, attempts to characterize memory functioning in terms of a single dimension have always run into difficulties. For example, in the present context, both strength and levels theories would expect a consistent correlation between memory for occurrence measures (recall or recognition) and identification-of-origin measures. Memory for occurrence and memory for origin sometimes do respond to the same variables. For example, both recognition and identification of origin were better for low as compared to high frequency category instances (Johnson, Raye, Foley, & Foley, in press, Experiment 2). However, these two measures are by no means always affected similarly. For example, directors, who asked the questions, were as good as speakers in later identifying answers that had been given but far worse at identifying who said what (Raye & Johnson, 1980, Experiment 2). And 6-year-olds who said some words and thought others were as good at identifying which words had occurred as were 6-year-olds who had listened to two speakers say the words; however, the children found it much more difficult to discriminate what they had said from what they had thought than to discriminate between what the two speakers had said (Foley et al., Note 5).

In some cases, memory for occurrence and identification of origin appear actually to be affected in opposite ways by the same variable. For example, recall and recognition were both better when subjects generated semantically related responses than when they generated responses sharing the same first letter as the stimuli. However, discriminating between items heard and items generated was more difficult in the related case (Johnson, Raye, Foley, & Foley, in press).

In the experiments in which Durso and Johnson (1980) compared memory for pictures and words under different orienting tasks, attending to the referent for a word rather than properties of the verbal name of the concept resulted in higher recognition, but it also resulted in more words that were later identified as having been pictures. With the explicit imagery tasks, there was also an increase in recognition relative to verbal tasks, but this was not accompanied by an increase in identifying words as pictures. In summary, it does not appear to us that the information and processes that are important in discriminating the origin of information can be equated with those that produce voluntary recall or a feeling of familiarity.

The factor that probably most distinguishes the process of voluntary recall from recognition is the dependence of recall on organizational information (Mandler, 1967; Tulving, 1968). In contrast, recognition is notable for the variety of types of information that can produce a "familiarity" response (e.g., rapid activation of semantic or sensory information, cognitive operations information, context cues). Reality monitoring, as a process, has its own properties, although to a certain extent it of course draws on information that is operative in recall and recognition. (For example, the potential usefulness in recognition of cognitive operations, especially, has received recent attention, e.g., Kolers, 1975; Russo & Wisher, 1976.) Although a model of reality monitoring does not offer a theory of recall or recognition, neither do theories of recall or recognition constitute theories of reality monitoring. Furthermore, understanding reality monitoring can contribute to our understanding of recall and recognition processes, for example, by providing mechanisms for editing out inappropriate responses and by accounting for failures in editing.

Summary and Conclusions

We have intended to focus attention on the processes involved in distinguishing between the perceived and the self-generated in memory (reality monitoring). We started with the assumption that perceiving differs from self-generated events such as thinking and imagining. That is, they are either different operations of the mind or operations of the mind resulting in characteristically different amounts of various types of information. Furthermore, we believe that the processes involved in reality monitoring, when they are functioning optimally, capitalize on these characteristic differences. We have outlined a working model of reality monitoring and have investigated some of the questions it raises. The present model proposes that reality monitoring can be based on some general dimensions—rather independent of the particular content of a memory—that serve as distinguishers between the two classes of memories. It is proposed that dimensions or attributes particularly central to reality monitoring include amount of contextual information (time and place), semantic detail, sensory information, and cognitive operations. The model additionally assumes that reality monitoring may involve more extended reasoning processes that take into account the content of particular memories and their relation to other knowledge available to the person, as well as metamemory assumptions of the person.

Overall, our results support these ideas: Memories from external and internal sources appear to differ in class-characteristic ways; confusion is increased by semantic and sensory similarity between memories from the two sources; confusion is reduced with increases in the information about cognitive operations associated with internally generated memories; memories based in perception have better spatial, temporal, and sensory information; and people's tacit assumptions about these characteristic differences are reflected in metamemory assumptions that influence reality monitoring judgments.

For the most part, the materials and procedures we have used seem to be extremely conducive to confusing external and internal sources of memories. The words, sentences, and pictures were not, after all, embedded in social or emotional contexts that might provide cues from related information stored in memory about the origin of a particular trace. Given the seemingly meager cues, it is perhaps remarkable that significant reality monitoring was obtained in some conditions with retention intervals as long as 7 and 10 days. This sensitivity to the origin of information, when a discrimination is called for, further recommends the usefulness of making a distinction between external and internal sources of information and the usefulness of attempting to incorporate such a distinction into models of memory.

The overall picture suggested by the evidence reviewed here is one of a memory system that preserves information about the origin of information remarkably well; the decision criteria through which this information is filtered, however, allow for some error in attributing memories to sources. We feel that the working model proposed here is a viable framework for generating questions and integrating results of studies directed at the processes involved in reality monitoring.

Reference Notes

1. Johnson, M. K., & Raye, C. L. *A working model of reality monitoring*. Paper presented at the annual

meeting of the Psychonomic Society, San Antonio, Texas, November 1978.

2. Levine, M., & Jankovic, I. N. *An introduction to spatial problem solving.* Manuscript submitted for publication.
3. Johnson, M. K. *Constructive aspects of memory: Historical antecedents.* Paper presented at the symposium on constructive processes in memory, annual meeting of the American Psychological Association, Chicago, September 1975.
4. Taylor, T. H., Johnson, M. K., Birnbaum, I. M., & Raye, C. L. *Alcohol and reality monitoring.* Manuscript submitted for publication.
5. Foley, M. A., Johnson, M. K., & Raye, C. L. *A developmental study of reality monitoring, comparing two types of judgments about memories.* Paper presented at the annual meeting of the Eastern Psychological Association, Hartford, Connecticut, April 1980.
6. Johnson, M. K., Raye, C. L., Foley, M. A., & Kim, J. *Pictures and images: Spatial and temporal information compared.* Manuscript in preparation, 1980.
7. Johnson, M. K., Raye, C. L., Foley, M. A., & Foley, H. J. *Perceptions and imaginations: sensory information compared.* Manuscript in preparation, 1980.
8. Johnson, M. K., & Raye, C. L. *Fact and fantasy: Confusion between perceptual experience and imaginations.* Paper presented at the annual meeting of the Psychonomic Society, St. Louis, Missouri, November 1976.

References

Atkinson, R. C., & Juola, J. F. Factors influencing speed and accuracy of word recognition. In S. Kornblum (Ed.), *Attention and performance, IV.* New York: Academic Press, 1973.

Atwood, G. An experimental study of visual imagination and memory. *Cognitive Psychology*, 1971, *2*, 290–299.

Bartlett, F. C. *Remembering: A study in experimental and social psychology.* Cambridge, Eng.: Cambridge University Press, 1932.

Bjork, R. A., & Whitten, W. B. Recency-sensitive retrieval processes in long-term free recall. *Cognitive Psychology*, 1974, *6*, 173–189.

Bobrow, S. A., & Bower, G. H. Comprehension and recall of sentences. *Journal of Experimental Psychology*, 1969, *80*, 455–461.

Bower, G. H. A multi-component theory of the memory trace. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 1). New York: Academic Press, 1967.

Bower, G. H. A selective review of organizational factors in memory. In E. Tulving & W. Donaldson, (Eds.), *Organization of memory.* New York: Academic Press, 1972. (a)

Bower, G. H. Mental imagery and associative learning. In L. W. Gregg (Ed.), *Cognition in learning and memory.* New York: Wiley, 1972. (b)

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

Bransford, J. D., & Johnson, M. K. Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior*, 1972, *11*, 717–726.

Bransford, J. D., & Johnson, M. K. Considerations of some problems of comprehension. In W. Chase (Ed.), *Visual information processing.* New York: Academic Press, 1973.

Brewer, W. F. Memory for pragmatic implications of sentences. *Memory & Cognition*, 1977, *5*, 673–678.

Brooks, L. R. Spatial and verbal components of the act of recall. *Canadian Journal of Psychology*, 1968, *22*, 349–368.

Brown, A. L. The development of memory: Knowing about knowing, and knowing how to know. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 10). New York: Academic Press, 1975.

Bruner, J. S. Going beyond the information given. In *Contemporary approaches to cognition.* Cambridge, Mass.: Harvard University Press, 1957.

Cameron, N. *Personality development and psychopathology: A dynamic approach.* Boston: Houghton Mifflin, 1963.

Cofer, C. N. Constructive processes in memory. *American Scientist*, 1973, *61*, 537–543.

Cole, W. G., & Loftus, E. F. Incorporating new information into memory. *American Journal of Psychology*, 1979, *92*, 413–425.

Corbett, A. T., & Dosher, B. A. Instrument inferences in sentence encoding. *Journal of Verbal Learning and Verbal Behavior*, 1978, *17*, 479–491.

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

Craik, F. I. M., & Lockhart, R. S. Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 1972, *11*, 671–684.

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

Crowder, R. G. *Principles of Learning and memory.* Hillsdale, N.J.: Erlbaum, 1976.

Davies, G. M., Milnee, J. E., & Glennie, B. S. On the significance of "double encoding" for the superior recall of pictures to names. *Quarterly Journal of Experimental Psychology*, 1973, *25*, 413–423.

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

Dooling, D. J., & Lachman, R. Effects of comprehension on retention of prose. *Journal of Experimental Psychology*, 1971, *88*, 216–222.

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

Erdelyi, M., Buschke, H., & Finkelstein, S. Hypermnesia for socratic stimuli: The growth of recall for internally generated memory list abstracted from a series of riddles. *Memory & Cognition*, 1977, *5*, 283–286.

Finke, R. A. The functional equivalence of mental images and errors of movement. *Cognitive Psychology*, 1979, *11*, 235–264.

Freud, S. *Negation* (Standard Ed., Vol. 19. James

Strachey, Ed.). Toronto, Canada: Clarke, Irwin, 1961. (Originally published, 1925.)
Freud, S. *Project for a scientific psychology* (Standard Ed., Vol. 1. James Strachey, Ed.). Toronto, Canada: Clarke, Irwin, 1966. (Originally published, 1895.)
Garrity, L. I. Electromyography: A review of the current status of subvocal speech research. *Memory & Cognition*, 1977, *5*, 615–622.
Geiselman, R. E., & Glenny, J. Effects of imagining speakers' voices on the retention of words presented visually. *Memory & Cognition*, 1977, *5*, 499–504.
Gibson, J. J. *The senses considered as perceptual systems*. Boston: Houghton Mifflin, 1966.
Gibson, J. J. *The ecological approach to visual perception*. Boston: Houghton Mifflin, 1979.
Hart, J. T. Memory and the memory-monitoring process. *Journal of Verbal Learning and Verbal Behavior*, 1967, *6*, 685–691.
Hasher, L., & Griffin, M. Reconstructive and reproductive processes in memory. *Journal of Experimental Psychology*, 1978, *4*, 318–330.
Hasher, L., Griffin, M., & Johnson, M. K. More on interpretive factors in forgetting. *Memory & Cognition*, 1977, *5*, 41–45.
Hasher, L., & Johnson, M. K. Interpretive factors in forgetting. *Journal of Experimental Psychology: Human Learning and Memory*, 1975, *1*, 567–575.
Hasher, L., & Zacks, R. T. Automatic and effortful processes in memory. *Journal of Experimental Psychology: General*, 1979, *108*, 356–388.
Heidbreder, E. *Seven psychologies*. New York: Appleton-Century-Crofts, 1933.
Hochberg, J. *Perception*. Englewood Cliffs, N.J.: Prentice-Hall, 1979.
Horowitz, M. J. *Image formation and cognition*. New York: Appleton-Century-Crofts, 1978.
Hume, D. *A treatise of human nature*. Oxford, Eng.: Clarendon Press, 1978. (Originally published, 1739.)
Jacoby, L. L. On interpreting the effects of repetition: Solving a problem versus remembering a solution. *Journal of Verbal Learning and Verbal Behavior*, 1978, *17*, 649–667.
James, W. *The principles of psychology*. New York: Dover, 1950. (Originally published, 1890.)
Jarvella, R. J., & Collas, J. G. Memory for the intentions of sentences. *Memory & Cognition*, 1974, *2*, 185–188.
Jenkins, J. J. Remember that old theory of memory? Well, forget it! *American Psychologist*, November 1974, pp. 785–795.
Johnson, M. K. What is being counted none the less? In I. M. Birnbaum & E. S. Parker (Eds.), *Alcohol and human memory*. Hillsdale, N.J.: Erlbaum, 1977.
Johnson, M. K., Bransford, J. D., & Solomon, S. K. Memory for tacit implications of sentences. *Journal of Experimental Psychology*, 1973, *98*, 203–205.
Johnson, M. K., Raye, C. L., & Durso, F. T. Reality monitoring: Second perceptions and thoughts. *Bulletin of the Psychonomic Society*, 1980, *15*, 402–404.
Johnson, M. K., Raye, C. L., Foley, H. J., & Foley, M. A. Cognitive operations and decision bias in reality monitoring. *American Journal of Psychology*, in press.
Johnson, M. K., Raye, C. L., Hasher, L., & Chromiak, W. Are there developmental differences in reality monitoring? *Journal of Experimental Child Psychology*, 1979, *27*, 120–128.
Johnson, M. K., Raye, C. L., Wang, A. Y., & Taylor, T. H. Fact and fantasy: The roles of accuracy and variability in confusing imaginations with perceptual experiences. *Journal of Experimental Psychology: Human Learning and Memory*, 1979, *5*, 229–240.
Johnson, M. K., Taylor, T. H., & Raye, C. L. Fact and fantasy: The effects of internally generated events on the apparent frequency of externally generated events. *Memory & Cognition*, 1977, *5*, 116–122.
Kimble, G. A. Mediating associations. *Journal of Experimental Psychology*, 1968, *76*, 263–266.
Kintsch, W. Memory for prose. In C. N. Cofer (Ed.), *The structure of human memory*. San Francisco: Freeman, 1976.
Klatzky, R. L. *Human memory: Structure and processes*. San Francisco: Freeman, 1980.
Köhler, W. *Gestalt psychology*. New York: Mentor Books, 1959. (Originally published, 1947.)
Kolers, P. A. Specificity of operations in sentence recognition. *Cognitive Psychology*, 1975, *7*, 289–306.
Kosslyn, S. M. Can imagery be distinguished from other forms of internal representation? Evidence from studies of information retrieval times. *Memory & Cognition*, 1976, *4*, 291–297.
Krech, D. Notes toward a psychological theory. *Journal of Personality*, 1949, *18*, 66–87.
Kreutzer, M. A., Leonard, C., & Flavell, J. H. An interview study of children's knowledge about memory. *Monographs of the Society for Research in Child Development*, 1975, *40* (1, Serial No. 159).
Landauer, T. K. Memory without organization: Properties of a model with random storage and undirected retrieval. *Cognitive Psychology*, 1975, *7*, 495–531.
Lashley, K. S. The problem of serial order in behavior. In N. J. Slamecka (Ed.), *Human learning and memory*. New York: Oxford University Press, 1967.
Mandler, G. Organization and memory. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 1). New York: Academic Press, 1967.
Mandler, G. Organization and recognition. In E. Tulving & W. Donaldson (Eds.), *Organization of memory*. New York: Academic Press, 1972.
Martin, C. J., Boersma, F. J., & Cox, D. L. A classification of associative strategies in paired-associate learning. *Psychonomic Science*, 1965, *3*, 455–456.
McGuigan, F. J. Covert oral behavior and auditory hallucinations. *Psychophysiology*, 1966, *3*(1), 73–80.
Mellor, C. S. First rank symptoms of schizophrenia. I: The frequency in schizophrenics on admission to hospital. II: Differences between individual first rank symptoms. *British Journal of Psychiatry*, 1970, *117*, 15–23.
Mill, J. *Analysis of the phenomena of the human mind, by James Mill* (edited with additional notes by J. S. Mill). New York: Kelley, 1967. (Originally published, 1829.)
Mill, J. S. *Analysis of the phenomena of the human mind, by James Mill* (edited with additional notes by J. S. Mill). New York: Kelley, 1967. (Originally published, 1869.)

Mintz, S., & Alpert, M. Imagery vividness, reality testing, and schizophrenic hallucinations. *Journal of Abnormal Psychology*, 1972, *79*, 310–316.

Neisser, U. *Cognitive Psychology*. New York: Appleton-Century-Crofts, 1967.

Neisser, U. *Cognition and reality*. San Francisco: Freeman, 1976.

Paivio, A. Mental imagery in associative learning and memory. *Psychological Review*, 1969, *76*, 241–263.

Paivio, A. *Imagery and verbal processes*. New York: Holt, Rinehart & Winston, 1971.

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

Posner, M. I., & Snyder, C. R. R. Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola Symposium*. Hillsdale, N.J.: Erlbaum, 1975.

Posner, M. I., & Warren, R. E. Traces, concepts and conscious construction. In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory*. Washington, D.C.: Winston, 1972.

Postman, L. Toward a general theory of cognition. In J. H. Rohrer & M. Sherif (Eds.), *Social psychology at the crossroads*. New York: Harper, 1951.

Pylyshyn, Z. W. What the mind's eye tells the mind's brain: A critique of mental imagery. *Psychological Bulletin*, 1973, *80*, 1–23.

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

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

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

Reid, T. An inquiry into the human mind, on the principles of common sense. In K. Lehrer & R. E. Beanblossom (Eds.), *Thomas Reid's inquiry and essays*. Indianapolis, Ind.: Bobbs-Merrill, 1975. (Originally published, 1764.)

Ross, M., & Sicoly, F. Egocentric biases in availability and attribution. *Journal of Personality and Social Psychology*, 1979, *37*, 322–336.

Russo, J. E., & Wisher, R. A. Reprocessing as a recognition cue. *Memory & Cognition*, 1976, *4*, 683–689.

Sachs, J. S. Recognition memory for syntactic and semantic aspects of connected discourse. *Perception & Psychophysics*, 1967, *2*, 437–442.

Schneider, W., & Shiffrin, R. M. Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review*, 1977, *84*, 1–66.

Segal, S. J., & Fusella, V. Influence of imaged pictures and sounds on detection of visual and auditory signals. *Journal of Experimental Psychology*, 1970, *83*, 458–464.

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

Sulin, R. A., & Dooling, D. J. Intrusion of a thematic idea in retention of prose. *Journal of Experimental Psychology*, 1974, *103*, 255–262.

Toglia, M. P., & Kimble, G. A. Recall and use of serial position information. *Journal of Experimental Psychology: Human Learning and Memory*, 1976, *2*, 431–445.

Tolman, E. C. Cognitive maps in rats and men. *Psychological Review*, 1948, *55*, 189–208.

Tulving, E. Theoretical issues in free recall. In T. R. Dixon & D. L. Horton (Eds.), *Verbal behavior and general behavior theory*. Englewood Cliffs, N.J.: Prentice-Hall, 1968.

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

Underwood, B. J. Attributes of memory. *Psychological Review*, 1969, *76*, 559–573.

Wickens, D. D. Encoding categories of words: An empirical approach to meaning. *Psychological Review*, 1970, *77*, 1–15.

Yuille, J. C. A detailed examination of mediation in paired-associate learning. *Memory & Cognition*, 1973, *1*, 333–342.

Received February 29, 1980 ■