2.18 Controlled Processes in Voluntary Remembering

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2.18.1 Introduction

The focus of this chapter is on voluntary remembering, in which memories are retrieved through a deliberate, goal-directed search process. Voluntary remembering occurs either in response to an external query or to a query that is generated internally by the person, usually in order to achieve some higher-order goal. For example, a person may try to recall the name of a person, to answer an exam question, or to recount an entire episode to a friend.

This type of remembering can be contrasted with involuntary memory, in which past events come to mind spontaneously and automatically, without any conscious intention to conjure them up. Involuntary memory often occurs during routine daily activity, without any apparent cue (Berntsen, 1996, 1998; Kvavilashvili and Mandler, 2004). An important subclass of involuntary memory that has received special attention is that of intrusive memories. Such memories, typically of traumatic events, occur not only in the absence of an intention to retrieve the events but also against the person's will (Koutstaal and Schacter, 1997; McNally, 1998). Intrusive memories reflect a failure of control over retrieval, because the person is unable to prevent these memories from arising, or fails to terminate them once they arise.

Although we concentrate here on voluntary remembering, we stress that the distinction between voluntary and involuntary memory processes is not sharp, and that any particular act of remembering may involve a mixture of these types of processes. For example, during the deliberate scrutinizing of one's memory for a particular detail, various memory fragments may suggest themselves, diverting the search in new directions. Sometimes, such fragments may even 'intrude' against the rememberer's will, blocking access to other, desired pieces of information.

2.18.2 Processes Involved in Remembering

We begin by outlining some general memory principles. In particular, we discuss (1) the role of retrieval cues and retrieval-encoding interactions in determining the accessibility of stored information and (2) the role of metamemory processes in monitoring and controlling the retrieval and reporting of that information. We then integrate these elements within a schematic framework that will guide a more detailed treatment of controlled processes in remembering.

2.18.2.1 Retrieval Cues and Retrieval-Encoding Interactions

The amount of information stored in memory exceeds by far the amount of information that can be accessed at any given point in time. In the terminology introduced by Tulving and Pearlstone (1966), much more information is *available* in memory than is *accessible* at any moment. Thus, although we may momentarily fail to retrieve the name of an acquaintance, we may still be able to recall it on some later occasion or recognize it from among several alternatives. The discrepancy between the availability of information and its accessibility to consciousness testifies to the critical role of retrieval processes in bringing stored information to mind (*See* Chapter 2.16; Roediger, 1999).

What prevents all of the available information from being accessed? What is the process by which people search for and recollect stored information from long-term memory?

Tulving (1983) promoted the now-accepted idea that memory is a joint product of stored memory traces and the cues that are present when retrieval is carried out. Thus, given the same conditions of study, retrieval success can vary greatly depending on the conditions of testing. For example, memory is generally better under cued than under uncued recall testing (Tulving and Pearlstone, 1966). The conditions that instigate retrieval often provide many useful retrieval cues. In externally posed queries, some of the cues can be found in the query itself, whereas others may be available in the more general retrieval context. Even when these cues are not sufficient to directly elicit the target item, they can help delimit the memory regions in which that item is likely to be found.

Cues differ considerably in their effectiveness for aiding retrieval. Research examining the effectiveness of extralist words in prompting the recall of studied words (Nelson et al., 2005) indicates that retrieval success varies with a large number of associative properties of the cue and of the target. For example, the larger the number of words that a cue word elicits in word association norms, the lower its effectiveness in facilitating the retrieval of a studied word. The most effective cues for retrieving an event are personal cues associated with the encoding of that event, because these cues are well integrated into the memory trace of the event (e.g., Mantyla, 1986). Many standard mnemonic techniques have people encode the target information together with specific cues that can later be used to prompt retrieval.

In a landmark article, Tulving and Thomson (1973) formulated the *encoding specificity* principle, which states that a cue presented during testing will be effective in aiding retrieval to the extent that it has been encoded together with the solicited memory target at study. A large amount of research has provided evidence for this principle (Tulving, 1983). It has also been extended in the form of the more general principle of *transfer-appropriate processing,* according to which retrieval is effective to the extent that the processing that occurs during retrieval reinstates the processing that took place during encoding (Kolers and Roediger, 1984; Srinivas et al., 1998).

In line with these principles, retrieval efficiency depends on the extent to which the testing conditions reinstate the overall conditions of study. Thus, retrieval is *context dependent,* in that memory is best when testing occurs in the same physical environment in which learning took place. For example, Godden and Baddeley (1975) found that divers who studied a list of words, either on land or underwater, performed better when tested in the same environment as at study rather than in the other environment. Participants have also been found to recall a larger number of words when tested in the same room in which they studied the words than when tested in a different room (Smith et al., 1978). Context-dependent effects are more likely when the environmental contexts differ substantially and when participants deliberately associate the studied material with features of the study environment (Smith and Vela, 2001). These effects are generally obtained for recall but not for recognition (Eich, 1985), suggesting that context reinstatement specifically facilitates retrieval.

Similar evidence exists for the state dependency of memory, indicating that memory performance is best when learning and testing occur under the same internal state. For example, what participants learn while drunk, they remember better while drunk than while sober, and vice versa (Goodwin et al., 1969). A similar pattern has been observed for the effects of marijuana (Eich et al., 1975) and mood (Eich and Metcalfe, 1989). Like context dependence, state-dependent memory benefits are more clearly observed for free recall than for recognition or cued recall (Eich, 1980).

2.18.2.2 Metacognitive Monitoring and Control Processes

Much of the work on the effects of cueing and retrieval-encoding interactions has been conducted within a conceptual framework that views the rememberer as a passive conduit through which information flows. For example, the work reviewed in the previous section has mainly emphasized the automatic effects of external and internal retrieval cues and retrieval-encoding interactions on memory performance. In recent years, however, there has been an increased emphasis on the active role of the rememberer in strategically regulating the process of remembering. This new emphasis is most prominent in the area of metacognition research, in which monitoring and control processes have been shown to play a critical role throughout the various phases of remembering (Barnes et al., 1999; Koriat, 2007): They are involved in deciding whether to initiate a memory search, what type of search and retrieval process to use, where in memory to search, when to terminate the search, whether or not to report the retrieved information, and at what level of precision or coarseness to report it. Such decision processes are integral components of remembering – influencing its course and the quality of its products. Traditional memory research has generally avoided the investigation of rememberer-controlled memory processes, perhaps because the operation of these processes was seen to conflict with the desire to achieve strict experimental control (Nelson and Narens, 1994; Koriat and Goldsmith, 1996a).

In the following section, we introduce a schematic framework to help identify and conceptualize the memory and metamemory processes involved in remembering, taking into account the critical role of retrieval cues and encoding-retrieval interactions, just described. This framework will guide the discussion of controlled processes in remembering throughout the remainder of this chapter.

2.18.2.3 A Schematic Framework

Let us consider the simple case in which a person is presented with a memory query in the form of a question. How does one come up with an answer to that query? Figure 1 presents a schematic framework for the processes involved in remembering. Broadly speaking, we first *search* our memory for the best answer we can find and then decide whether and how we want to *report* it. For simplicity, we describe the processes involved in remembering sequentially, although we assume that they are actually somewhat overlapping and parallel.

Memory search is conceptualized here as an iterative process. First, the rememberer sets parameters that define what he or she is looking for in memory and determine broadly the manner in which that information will be accessed. The search parameters include cues that are provided explicitly in the memory query and additional cues that are available in the overall retrieval context or generated by the rememberer in response to the query (cf. target descriptions in Norman and Bobrow, 1979). The parameters also include search criteria that define what will be considered a satisfactory answer to the query (verification criteria in Norman and Bobrow, 1979) and a rough metacognitive assessment of the accessibility of the answer. Another important parameter is the search strategy that will be invoked.

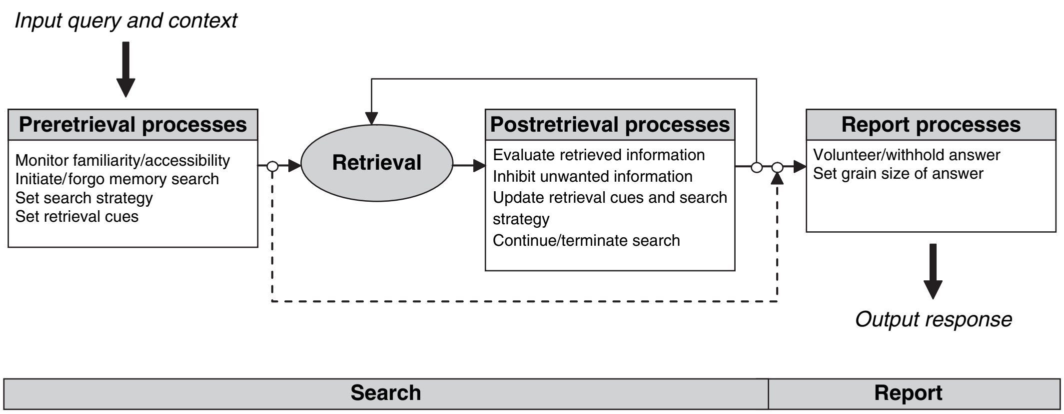

Figure 1 A schematic framework for the memory and metamemory processes involved in remembering (dashed line represents the decision to forgo a memory search).

These parameters determine the initial course of the retrieval of information from memory, as well as whether retrieval will be attempted at all. Because it appears to capture much of the mainstream thinking about memory retrieval, we adopt Tulving's (1983) concept of *ecphory* to describe the specific operation of retrieval during a (sometimes) more prolonged memory search process. According to this concept, when an item of information is encoded, a memory trace (engram) is created that includes not only the item itself but also other information from the cognitive context at the time of encoding (related thoughts, for instance). During retrieval, parts of the encoded engram combine synergistically with the search cues to produce "a conscious memory of particular aspects of the original event" (Tulving, 1976, p. 40). Consequently, the retrieved (ecphoric) information that comes to mind is actually a combination of the search cues and stored information. We assume that, although rememberers cannot control the process of ecphory itself, which is conceptualized here as an automatic, ballistic operation (Moscovitch, 1994; Guynn, 2003; but see Naveh-Benjamin et al., 2000), they can influence the outcome of a memory search by controlling the parameters that are used for the individual operations of retrieval and the overall strategy that determines the number and nature of these operations.

A very different conception of remembering is offered by the reconstructive approach (Bartlett, 1932; Neisser, 1967; Barclay, 1986), in which remembering is assumed to involve reconstructive inferences that may supplement the retrieval process. In terms of the framework presented here, however, it should not matter much whether a candidate answer is produced by a retrieval process such as ecphory or, instead, by some type of inferential, schema-based reconstruction process; much of the surrounding control processes would remain essentially the same. In any case, there has been very little work, if any, detailing the processes involved in reconstructive remembering.

The results of each retrieval (ecphory) attempt are evaluated by the rememberer to determine whether the sought-for information has been reached. If not, the search parameters may be refined, and a fresh retrieval attempt is made. Because of the critical role that search parameters play in retrieval, the metacognitive control exerted in the evaluation of results and in the consequent updating of these parameters has a high impact on remembering. The iterative search process is terminated either when the rememberer gives up (e.g., after drawing a blank or running out of time) or when a retrieved answer is identified as the best one that can be found.

Once a best-candidate answer has been reached, other factors now come into play in converting that answer into an overt memory response (Tulving, 1983). For example, the decision whether to report the best answer or withhold it and respond "don't know" (Koriat and Goldsmith, 1996b), and the decision regarding the level of generality or precision (grain size) at which to report the answer (Goldsmith et al., 2002), are both under the strategic control of the rememberer.

In what follows, our discussion of controlled processes in remembering will be divided in terms of the processes that take place before retrieval, those that take place after the retrieval of some candidate answer, and finally, the processes that take place in deciding what to report, and how.

2.18.3 Controlled Preretrieval Processes

2.18.3.1 Deciding Whether to Initiate or Forgo a Memory Search

When confronted with a memory query, one does not always proceed immediately to initiate retrieval. Rather, in many cases a preliminary feeling of knowing (FOK) may signal that it is not worthwhile to search for the answer, either because it is not in memory or because it might require more time and effort than is warranted under the circumstances. Thus, a preliminary monitoring stage may be postulated in which one makes a rough assessment regarding the availability of the answer in memory and the effort needed to access it. The initial FOK is assumed to rely on the overall familiarity of the query (Schwartz and Metcalfe, 1992; Nhouyvanisvong and Reder, 1998) and the extent to which it brings to mind some fragmentary clues (Koriat, 1993, 1995). Reder (1987) argued that a fast, preretrieval FOK is routinely and automatically made in response to the familiarity of the terms of a memory query. She found that the latency of making a fast FOK is shorter than that of accessing the answer, suggesting that preliminary FOK is not based on the retrieval of an answer. If the question does not produce a feeling of familiarity, chances are that one will not initiate a deliberate search for the answer. Glucksberg and McCloskey (1981; see also Kolers and Palef, 1976), for example, showed that people answer "I don't know" more rapidly when no potentially relevant information is accessible ("Does Margaret Thatcher use an electronic toothbrush?") than when some information can be retrieved ("Is Kiev in the Ukraine?"). They proposed that low preliminary FOK can cause people to forgo a memory search. Note, however, that a preliminary 'Don't Know' response appears not to prevent automatic activations that may ultimately evoke the solicited target (Koriat and Lieblich, 1977).

Using an episodic cued recall task, Malmberg (in press) has recently shown that enhanced cue familiarity increases the time participants search for the answer before giving up and also increases the likelihood of retrieving the correct answer. Familiarity, however, appeared to have little effect when participants were led to believe that familiarity was not correlated with the memorability of the target. Thus, it would seem that the effects of preliminary FOK on the initiation of a memory search are at least partly strategic. In fact, Reder and her associates argued that preliminary FOK can guide the choice of question-answering strategy, as discussed in the next section. Note also that cue familiarity may affect not only the initiation of the search for the target but also the continuation of the search after it has been initiated, as suggested, perhaps, by the results of Malmberg.

2.18.3.2 Choosing a Search Strategy

Several strategies of memory search have been discussed in the literature. The strategy used to search memory determines in part the context of retrieval, the generation of additional retrieval cues, and the ways those cues are used to retrieve information from memory. By controlling the choice of search strategy, either initially or after a previous strategy has failed, the rememberer can influence the course of remembering as well as its results.

One prominent strategy is embodied in the classic two-stage generate–recognize model (Bahrick, 1969, 1979). In this strategy, the rememberer uses the available cues to define a region in memory in which the solicited item is likely to reside (e.g., "vegetables," "words strongly related to *doctor*," "Spanish family names"). Candidate items are then generated, and a subsequent monitoring process is used to select (recognize) the target from among them. For example, when trying to recall the name of an old acquaintance, one might run through a number of female names in one's head and hope that one of the names will be recognized as the target. In response to theoretical and empirical challenges (e.g., Thomson and Tulving, 1970; Tulving and Thomson, 1973; Wiseman and Tulving, 1976), more recent versions of the generate–recognize model (Jacoby and Hollingshead, 1990; Weldon and Colston, 1995; Higham and Tam, 2005, 2006) acknowledge that generated candidates may be a joint product of semantic and episodic influences (*See* Chapter 2.27). Nevertheless, these models continue to embody a memory search strategy that might be portrayed as 'casting a wide net' rather than trying to retrieve the target item directly.

Metacognitive knowledge about subtle characteristics of the encoding and retrieval contexts can guide the controlled use of the generate–recognize strategy. For example, Higham and Tam (2005) found that participants were sensitive to the strength of the semantic cue–target relations in studied lists of paired associates, and that this awareness influenced the set of plausible candidates that were generated during a cued-recall test: When participants expected weak cue-to-target relations, they were not likely to generate targets strongly related to the retrieval cues. Koriat and Lieblich (1974) also observed that participants' guesses of a target word while in a tip-of-the-tongue (TOT) state are sensitive to the specific definition of the population from which the target is said to have been drawn.

Clearly, however, rememberers do not always resort to a generate–recognize strategy. As Bahrick (1979) has observed, one does not recall the name of his wife by generating a series of female names and selecting the correct name. Instead, in this case and many others, a direct-retrieval process is invoked, in which relatively specific and constrained retrieval cues allow one to 'home in' directly on the target representation in memory. This process is assumed to be automatic and effortless. In fact, Bahrick (1979) suggested that only when direct retrieval fails do people resort to other strategies. Guynn and McDaniel (1999) proposed that, when a large amount of contextual information has been encoded along with the target, rememberers prefer direct retrieval over the generate–recognize strategy because the contextual information facilitates a narrowly focused ecphory operation. Higham and Tam (2005) suggested that direct-retrieval and generate–recognize strategies can be conceived as lying along a continuum representing the degree to which retrieval is constrained.

Jacoby and colleagues proposed a controlled mode of retrieval that they call source-constrained retrieval – the deliberate use of target-source information to constrain what comes to mind during retrieval. In a series of experiments (Jacoby et al., 1999, 2005a,b), participants studied a list of words under shallow or deep encoding and were tested using an old/new recognition test. When they were later tested for their memory of the foils that appeared on the first test, their performance was better for the foils that had appeared on a test of deeply encoded study items than for those that had appeared on a test of shallowly encoded study items. This result was taken to suggest that the participants had used their metacognitive knowledge of the original encoding operations to constrain their retrieval on the first test by applying these same operations to the test probes. The same pattern was not found for elderly participants, presumably because elderly people fail to take advantage of their knowledge about encoding operations to constrain their retrieval.

The next strategic choice to be considered involves basing one's answer on reconstructive inference rather than on the reproductive retrieval of stored information (Neisser, 1984; Hall, 1990). Several researchers have proposed that the choice between reconstructive and reproductive remembering is, at least partly, under the control of the rememberer (Reder, 1987; Ross, 1989). Reder (1987) showed that, when the familiarity of the question is low, people tend to answer the question by making plausible inferences about the answer on the basis of a variety of cues, rather than by attempting to retrieve the answer directly from memory. She also suggested that the tendency to rely on plausible inference increases in old age (Reder et al., 1986). Similarly, Ross (1989) proposed that, when accuracy motivation is low, people tend to utilize a schema-based reconstruction strategy rather than engaging in an effortful reproductive retrieval. For example, in attempting to recall one's past attitudes, a person might use his or her present attitudes as a benchmark against which to reconstruct the past attitudes in light of an implicit theory of stability or change. To reconstruct how one felt 5 years ago, one might ask oneself: Is there any reason to believe that I felt differently then than I do now (Ross, 1989)? Several studies have shown that people tend to exaggerate the similarity between their present and past attitudes (e.g., Bem and McConnell, 1970).

Finally, a fourth general strategy can be identified that might be called 'mediated' retrieval, in which one initially sets out to retrieve contextual information that may then assist in generating further cues to guide more direct retrieval attempts (e.g., Williams and Hollan, 1981; Reiser et al., 1985). For example, when trying to remember the gifts one received at one's last birthday party, a person might first try to retrieve the general party context, including the friends who attended, in order to make the subsequent retrieval of the gifts themselves more efficient.

2.18.3.3 Specifying the Initial Context of Search and Generating Internal Retrieval Cues

As discussed earlier, retrieval cues play a critical role in the efficient retrieval of information from memory. That role begins with the cues that are presented explicitly in the memory query and those that are available implicitly in the more general retrieval context. Such cues may aid retrieval either automatically or in a more deliberate and controlled manner. The controlled exploitation of cues is particularly transparent when retrieval is difficult and prolonged.

One searches one's memory in a controlled manner by specifying certain characteristics of the solicited information as retrieval cues. Norman and Bobrow (1979) termed such specifications 'descriptions.' Descriptions may include the context of the solicited event (e.g., time, place) and additional information. Norman and Bobrow suggested that the descriptions are continually updated after each retrieval attempt. Following up on these ideas, Burgess and Shallice (1996) proposed a controlled descriptor process that is responsible for translating memory queries into a form that corresponds to the way the relevant information is stored in long-term memory. They suggested that one of the causes of clinical confabulation disorder is impaired descriptor processes.

Other researchers have put forward similar ideas. Norman and Schacter (1996; Schacter et al., 1998), for example, used the term 'focusing' to describe the preliminary stage in retrieval in which the rememberer refines the description of the characteristics of the sought-for episode. Similarly, Moscovitch and Melo (1997) suggested that confabulators might be impaired in the strategic use of general and personal knowledge to constrain their memory search so as to home in on the target. Dab and colleagues (Dab et al., 1999) described a patient whose confabulations apparently stem from deficient cue setting. In contrast to other confabulators, this patient had preserved memory and postecphoric verification abilities but exhibited a selective impairment of the search descriptor process. Finally, the work of Jacoby and colleagues on source-constrained retrieval, mentioned earlier (Jacoby et al., 2005a,b), suggests that rememberers use contextual knowledge to constrain their retrieval queries, and that elderly people may be particularly deficient in this type of retrieval control.

Once an initial search description has been formed, further cues may be recruited during the search. Indeed, several studies have identified a reiterative pattern that occurs in the course of arduous remembering. Williams and Hollan (1981), for example, proposed that remembering consists of a series of kernel retrieval processes, each including three stages: a memory region is specified in which a search is to be conducted, that region is searched for additional clues, and the information retrieved is evaluated. Information that passes the evaluation is then used to guide the next retrieval attempt. This cycle is repeated, gradually refining the description of the information to be searched, until the search closes in on the target. Thus, in attempting to retrieve the names of high school classmates, participants in Williams and Hollan's (1981) study produced an enormous amount of information that was incidental to the task of recalling the names, including details about the school, about where people lived, and so forth. Examination of this information suggested that its main function was to probe one's memory for additional clues that could better specify a new context for search.

Similarly, Reiser and his associates (Reiser et al., 1985, 1986), in studying the recall of autobiographical episodes, also emphasized that one memory retrieval can be undertaken in order to provide cues for a subsequent retrieval. According to their context-plus-index model, specific personal episodes are recalled by first recovering the general context in which they were likely to have been encoded and then specifying the features that uniquely distinguish these experiences from others in that context. They proposed that scripts (e.g., 'eating in restaurants'; Schank, 1982) typically serve as convenient retrieval contexts. Burgess and Shallice (1996) also noted that participants did not always retrieve the target memory record directly but sometimes recovered a useful cue first. For example, it was not uncommon for participants to answer the question "What was the weather like yesterday morning?" by trying to remember first what they were wearing.

Similar processes appear to take place in retrieving information from semantic memory. A study by Walker and Kintsch (1985) suggests that retrieving the members of natural categories also relies on the recovery of context. Verbal protocols suggested a series of two-stage cycles: generating a context in which category members are likely to be found, and then using that context as a retrieval cue to produce the category members themselves. Interestingly, most of the contexts generated were episodic rather than abstract-semantic (e.g., in searching for automobiles, one might visualize the cars in a parking lot or in front of one's dormitory).

We noted earlier that retrieval is more efficient when the retrieval context closely matches the encoding context. Rememberers can take advantage of this principle by deliberately attempting to reinstate the encoding context. Thus, for example, a study by Smith (1979) suggests that mental reinstatement of the learning environment may be almost as beneficial for retrieval as actual, physical reinstatement. Notably, mental context reinstatement has been incorporated into the Cognitive Interview (Fisher and Geiselman, 1992) as a means of facilitating witness recollection; prior to answering specific questions about a past event, witnesses are instructed to mentally recreate the context or state that existed at the time of the original event. Another memory principle that can be taken advantage of in a controlled manner is the effect of schema activation on retrieval. For example, in Anderson and Pichert's (1978) classic experiment, participants read a story about two boys playing in a house from one of two perspectives, that of a home buyer or that of a burglar. After a standard recall task, participants were asked to recall the story again, now adopting the other perspective. The participants could now recall additional details that were related to the new perspective.

So far we have emphasized the deliberate use of retrieval cues in remembering. However, throughout the search, automatic activations can bring to mind a variety of associations and memories. Thus, retrieval often involves a complex interplay between a controlled process and the automatic involuntary emergence of ideas and associations (Collins and Loftus, 1975; Nelson et al., 1998) that emanate from the retrieval context or from the information already recovered (Moscovitch, 1989; Jacoby, 1991). Sometimes the controlled process will seize onto ideas that emerged involuntarily and use them as intermediate cues on the way to the sought-for target. In other cases they may be recognized as unwanted 'interlopers,' and effort will be exerted to oppose their interfering influence (section 2.18.5.3; Jones, 1989).

2.18.4 Retrieval (Ecphory)

As explained in section 2.18.3.2, in this chapter the retrieval-ecphory operation is treated as an automatic, ballistic process whose course is not under the control of the rememberer. Understanding the nature of this process has been one of the long-standing goals of memory research, and many formal models have been proposed to describe it (e.g., Raaijmakers and Shiffrin, 1980, 1981; Hintzman, 1987; Murdock, 1993). We assume that rememberers can exert control over retrieval only by affecting the input to the retrieval operation. Such control, as the preceding discussion suggests, can have a very large impact on the outcome of the retrieval operation in particular, and on the search process generally. In addition, rememberers also make use of the retrieval output to guide subsequent retrieval operations and to convert the retrieved information into an overt response. These aspects of postretrieval control are covered in the following sections.

2.18.5 Controlled Postretrieval Processes

As noted earlier, search and retrieval can be conceptualized as a reiterative process in which a description is formed, cues are recruited to facilitate the search, candidate answers are evaluated, and – depending on the results – the search may be terminated or the cycle may continue. In this section we focus on processes that take place following the retrieval of candidate answers. These include monitoring and control processes that aid in achieving one's goals. First, rememberers monitor whether the search is on the right track and, if necessary, refine and reformulate the memory description or change the retrieval strategy. Second, they evaluate the correctness of retrieved candidate answers in deciding whether or not the target has been reached. Third, inhibition may be applied to reduce the interference from items of information that come to mind but are judged to be incorrect. Finally, in deciding whether to continue or terminate the search, rememberers may assess the likelihood of success and the additional time and effort needed to reach the target. Such an assessment may be particularly important when remembering is done under pressure, for example, when a lecturer quickly decides to settle for 'several researchers have shown' instead of continuing to search for the specific names of the researchers. We examine each of these processes in turn.

2.18.5.1 Updating and Refining the Search Strategy and Internal Retrieval Cues

In the previous section we emphasized the control exerted by rememberers in setting up the initial search parameters (internal retrieval cues and overall search strategy). We also noted, and reemphasize here, the reiterative-cyclical nature of the search process. After each retrieval attempt, these search parameters may be refined and reformulated in light of the information that has been retrieved. As observed by Norman and Bobrow (1979) and by several researchers subsequently, the 'descriptions' of the sought-for information are continuously updated during the retrieval cycle, based on newly retrieved information.

Search strategies may also be changed in light of the retrieved information. For example, participants may abandon one strategy in response to the retrieval of information that appears to be particularly useful in the context of a different strategy (Williams and Santos-Williams, 1980). When a controlled, deliberate search proves unsuccessful, however, rememberers may decide to relinquish strategic control altogether, adopting a passive-receptive attitude. Nickerson (1981) noted that, in retrieving words from lists, participants often begin with a passive attitude and then switch to an active, systematic search when the passive approach no longer yields a satisfactory return (see also Walker and Kintsch, 1985). Koriat and Melkman (1987) observed a similar pattern and also showed that, when attentional resources are diverted, the retrieval of words from a list becomes less controlled, moving along associative links between the words rather than along conceptual-logical relations.

2.18.5.2 Evaluating the Correctness of Retrieved Information

A great deal of work emphasizes the importance of postretrieval monitoring processes that evaluate the relevance and correctness of retrieved information (e.g., Burgess and Shallice, 1996; Kelley and Jacoby, 1996; Schacter et al., 1998; Koriat, 2000; Mitchell and Johnson, 2000). On the basis of these processes, one decides not only whether each piece of information that comes to mind is correct or not but also whether the search is on the right track, whether to continue searching for additional candidate responses, and which of the many candidates that came to mind is the best candidate answer. In a later section we discuss the further crucial role of monitoring processes in deciding whether or not to report the best candidate answer, and in what form. The operation of these processes is particularly important in real-life situations (e.g., eyewitness testimony) in which a premium is placed on accurate reporting.

Discussions of metacognition generally distinguish between two basic types of monitoring processes (Koriat and Levy-Sadot, 1999). Information-based processes involve analytic, deliberate inferences in which beliefs and knowledge in long-term memory are consulted and weighed to reach an educated judgment. Experience-based processes, in contrast, are sensitive to online mnemonic cues, such as retrieval fluency, that derive from the experience of remembering itself. These cues give rise to subjective feelings (e.g., a sense of conviction), which then serve as the bases for metacognitive judgments (Strack, 1992; Kelley and Jacoby, 1996; Koriat and Levy-Sadot, 1999).

As an example of information-based, analytic monitoring, rememberers may base their confidence in the correctness of a particular candidate response on the weight of the evidence that they can marshal in favor of that candidate relative to the evidence in support of the alternative candidates (e.g., Koriat et al., 1980; Griffin and Tversky, 1992; McKenzie, 1997; Yates et al., 2002). Rememberers may also base their confidence on metacognitive beliefs about their own competence and skills (Dunning et al., 2003; Perfect, 2004) and about the way in which various factors can affect memory performance (Dunlosky and Nelson, 1994; Mazzoni and Kirsch, 2002).

In contrast to this type of analytic and deliberate evaluation, experience-based monitoring relies on mnemonic cues that derive from the online processes of remembering. Such cues as the ease with which information comes to mind, or its vividness, may contribute implicitly to the subjective confidence in the correctness of that information. For example, it has been observed that the more effort and the longer the deliberation needed to reach an answer, the lower is the confidence in that answer (e.g., Nelson and Narens, 1990; Robinson et al., 1997; Koriat et al., 2006). Kelley and Lindsay (1993) showed that when priming speeds up the emergence of an answer, confidence judgments also increase accordingly. This effect occurred even for plausible but incorrect answers. Although typically correct answers are associated with shorter latencies than incorrect answers, so that response latency is diagnostic of the correctness of the answer that is retrieved or recognized, there are situations in which retrieval fluency can be misleading (Chandler, 1994). For example, asking participants to imagine some childhood events increased confidence that these events did indeed happen in the past (Garry et al., 1996). Merely being asked about an event twice also increased subjective confidence. Possibly, imagining an event or attempting to recall it increases its retrieval fluency, which in turn contributes to the confidence that the event has occurred.

A prominent theory that includes both automatic and controlled monitoring processes is Johnson's (1997) source monitoring framework. According to this framework, in discriminating the origin or source of information, people take advantage of the fact that mental experiences from different sources (e.g., perception vs. imagination) differ on average in their phenomenal qualities such as visual clarity and contextual details (*See* Chapter 2.19). Although these diagnostic qualities can support a rapid, heuristically based source monitoring, sometimes more strategic, deliberative processes may be applied. Both types of processes require setting criteria for making a judgment and procedures for comparing activated information to the criteria. Closely related processes have been discussed in the context of Jacoby and Kelley's attributional approach to memory (e.g., Jacoby et al., 1989; Kelley and Rhodes, 2002) and in Whittlesea's SCAPE framework (e.g., Whittlesea and Williams, 2001a,b; Whittlesea, 2002).

Many memory errors are the result of source confusions – the attribution of retrieved elements to the wrong context (Johnson, 1997). For example, the effects of misleading postevent information have been attributed, at least in part, to deficient source monitoring, by which the postevent misinformation is wrongly attributed to the witnessed event (see Lindsay, 1994; Mitchell and Johnson, 2000). Source confusions can arise when the activated information during retrieval is incomplete or ambiguous, or when the cues used in attributing information to sources are not diagnostic. Divided attention during encoding has been found to impair source monitoring (Craik and Byrd, 1982), presumably because they disrupt contextual binding. High perceptual similarity between two sources, as well as similarity in the encoding processes, also increase source confusions (Ferguson et al., 1992; Dodson and Johnson, 1996). Although vividness and perceptual detail are generally diagnostic of actual memories (Conway et al., 1996), thinking about imagined events also increases their vividness, thereby impairing reality monitoring for these events (Suengas and Johnson, 1988).

Several mechanisms have been proposed that can help reduce source confusions and reject false memories (see Odegard and Lampinen, 2006). For example, distinctive encoding manipulations have been shown to reduce the occurrence of false recall and recognition. Such manipulations include presenting each word together with a picture representing it (Israel and Schacter, 1997; Schacter et al., 1999), visual rather than auditory presentation (Smith and Hunt, 1998), having participants say the words out loud at study (Dodson and Schacter, 2001), or having the participants rate the pleasantness of the words during study (Smith and Hunt, 1998). Schacter et al. (1999) have explained such findings in terms of a *distinctiveness heuristic,* a mode of responding based on participants' metacognitive belief that true memory of studied items should include recollection of distinctive details. Participants can use this heuristic to reject foils that evoke memorial experiences lacking the distinctive qualities known to be present at study. A similar metacognitive strategy has been suggested by Strack and Bless (1994) to underlie judgments of nonoccurrence. They showed that, if an event is judged to be memorable (salient) but elicits no clear recollection during testing, it can be rejected with high confidence as not having occurred. In contrast, in the absence of a clear recollection of a nonmemorable event, rememberers may infer that the event actually had occurred but had simply been forgotten. Also, studying material under conditions unfavorable for learning (or expecting fast forgetting, Ghetti, 2003) results in a relatively high rate of false alarms for nonmemorable distractors.

In the framework of Fuzzy Trace Theory, Brainerd et al. (2003) proposed recollection rejection as another mechanism for identifying and editing out false memories. By this mechanism, a distractor that is consistent with the gist of a presented item may be rejected when the verbatim trace of that item is recollected. Thus, participants can reject 'SOFA' as having occurred in the study list if they recall that the word 'COUCH' was in the list and if they have noticed that all words in the study list were unrelated to each other. Recollection rejection has been shown to operate in rejecting false narrative statements (Brainerd et al., 2006) and may also occur for self-generated candidate responses that emerge during recall.

Finally, Burgess and Shallice's (1996) model, mentioned earlier, also includes a mechanism for the screening of retrieved information. The model assumes that 'editor' processes are initiated whenever a descriptor is set. These processes check that retrieved memory items do not contradict previously retrieved elements of the event, and that they are compatible with the overall descriptor requirements. Evidence for the operation of such a mechanism comes from error corrections in verbal protocols obtained during autobiographical recollections of recent everyday events. One participant, who was asked to describe the first thing that came to mind that happened to him in January, was recorded thinking:

> Something that happened in January? . . . I completed a major sale. No! I didn't complete a major sale in January at all. I didn't sell anything at all in January because I remember looking at the board and that was blank." (Burgess and Shallice, 1996: 382)

Applying their model to the study of confabulations, Burgess and Shallice (1996) pointed to impaired editor processes, along with insufficiently focused retrieval descriptions, as two of their main causes.

2.18.5.3 Inhibiting Wrong/Irrelevant Information

As noted earlier, a great deal of unwanted information is retrieved during the search for a solicited target, which must be cast aside as the search continues. Therefore, a potentially important contributor to successful retrieval is the efficient inhibition of such incidental information and, in particular, the inhibition of rejected candidate answers that would otherwise keep coming to mind and interfering with the search. The effect of such interference has been emphasized in studies of the TOT phenomenon, in which the failure to retrieve the correct target while in the TOT state is attributed, in part, to the interfering effect of 'interlopers' – plausible but wrong candidate answers that share some features with the target (Reason and Lucas, 1984; Jones, 1989; Burke et al., 1991).

It has been observed that retrieving some items of a studied list with the aid of category cues impairs the later recall of other studied items from the same category, but not of other unrelated studied items (Anderson et al., 1994; Anderson and Spellman, 1995; Anderson, 2003). This retrieval-induced forgetting has been attributed to inhibitory mechanisms that operate to suppress unwanted information in order to overcome retrieval competition (Anderson et al., 2000; Levy and Anderson, 2002). Hasher and her colleagues (Hamm and Hasher, 1992; Hasher et al., 1999) suggested that inhibitory processes are used to suppress goal-irrelevant information that has been activated in working memory, or to prevent candidate answers from being immediately reported, so that other candidates can also be retrieved and considered (Hasher and Zacks, 1988; Hasher et al., 1999; Radvansky et al., 2005). May and Hasher (1998) demonstrated that the controlled inhibition of the irrelevant contents of working memory is deficient in older adults, and in young adults during their off-peak time of the day.

Directed forgetting is another example of controlled inhibition in memory. Research indicates that, when people are instructed to forget a previously learned piece of information, they are often successful in reducing or eliminating the interference between that information and the subsequent retrieval of to-be-remembered information (Bjork and Woodward, 1973; Bjork, 1989). The underlying mechanism seems to involve inhibiting the retrieval of the to-be-forgotten information. Indeed, when memory is tested through recognition or relearning, or when it is tested through indirect measures of memory such as priming, performance on the to-be-forgotten items is typically comparable to that of to-be-remembered items (Basden et al., 1993; Bjork and Bjork, 1996).

2.18.5.4 Deciding Whether to Continue or Terminate the Search

We have characterized the search process as reiterative, but it is, of course, not endless. At some point, the memory search must terminate – either when no relevant information can be retrieved or after some information (correct or incorrect) has been retrieved, and the rememberer either believes that the target has been reached or has given up. The decision to stop the search is at least partially under the control of the rememberer and is based on such factors as level of confidence in the best candidate answer produced so far, the feeling that one knows the answer even though it has not (yet) been retrieved, the amount of time and effort invested so far, and the incentives for successful performance.

Whereas it is self evident that high confidence in a retrieved answer will induce the rememberer to terminate the memory search, there is also evidence that this decision is affected by the feeling of knowing (FOK) regarding answers that have not yet been retrieved. When FOK is high, participants spend more time searching for the target before giving up than when FOK is low (Nelson and Narens, 1990; Barnes et al., 1999).

The decision to continue the search is also affected by the expected reward for correct retrieval. Loftus and Wickens (1970) found that the larger the reward offered at the time of retrieval, the more time participants spent before terminating the retrieval, although this did not affect their performance. More direct evidence comes from Barnes et al. (1999) in examining the 'willingness to continue searching' component of their metacognitive retrieval model. They assumed that the willingness to continue searching depends on two conflicting incentives – the reward for finding the correct answer and the cost of spending additional search time. For example, in most exam situations, continuing to search for an answer to one question is beneficial to the extent that this allows the correct answer to be reached, but it is detrimental to the extent that this takes away from the time that can be spent on other questions. Manipulating the reward for each correct answer and the cost of additional search time on a cued-recall test, Barnes et al. (1999) found that both higher rewards and lower costs induced the participants to take longer before responding. This increased the number of correct responses and decreased the number of omission errors without increasing the number of commission errors – indicating that the additional retrieval effort was not in vain.

2.18.6 Controlled Report Processes

2.18.6.1 Deciding Whether or Not to Report an Answer

Much memory research has used forced-report testing procedures, such as forced-choice recognition or forced cued recall, in which the participant is required to select/provide an answer to each and every test probe. In most everyday memory situations, however, as in many laboratory recall tasks, rememberers have the option of *free report;* that is, they are allowed to decide for themselves whether to answer a particular memory query, or instead to respond 'don't know' (or refrain from responding).

The option of free report is particularly crucial in situations, such as courtroom testimony, in which a premium is placed on accurate reporting. Koriat and Goldsmith (1994, 1996b) showed that, when participants are given the option of free report and a moderate incentive for accurate reporting (a penalty for each wrong answer equal to the reward for each correct answer), they are able to boost the accuracy of what they report substantially in comparison to forced-report testing. They do so by withholding best-candidate answers that are likely to be wrong. For example, in one study (Koriat and Goldsmith, 1994, Experiment 1), the option of free report allowed participants to increase their recall accuracy from 47.6% in forced report to 76.6%. Moreover, when given an even stronger accuracy incentive (a 10:1 penalty-to-reward ratio; Koriat and Goldsmith [1996b, Experiment 1], or the loss of all winnings if a single wrong answer is volunteered, Koriat and Goldsmith [1994, Experiment 3]), report accuracy was boosted even further. In each case, however, the increased report accuracy came at the price of a reduction in the quantity of correct information reported – that is, a quantity-accuracy trade-off (see also Barnes et al., 1999; Kelley and Sahakyan, 2003).

The existence of a quantity-accuracy trade-off means that rememberers must strive to find a compromise between these two conflicting aims in regulating their reporting. Consider, for example, a courtroom witness who has sworn "to tell the whole truth and nothing but the truth." Generally, it is not possible to fulfill both endeavors simultaneously. How, then, should the witness proceed?

Koriat and Goldsmith (1996a) proposed a model (for similar models, see Barnes et al., 1999; Higham, 2002), in which one first assesses the likelihood that one's best candidate answer is correct and then compares this assessment to a report criterion. The answer is volunteered if its assessed probability of being correct passes the criterion; otherwise, it is withheld. The setting of the criterion is assumed to depend on the relative incentives for accuracy and quantity; in general, report accuracy should increase, but the quantity of correct answers should decrease as the criterion level is raised.

In line with this model, a very strong relationship was found between the tendency to report an answer under free-report conditions and subjective confidence in the answer (assessed probability that the answer is correct). In one study, for example, the mean within-participant gamma correlation between confidence in the answer and the decision to volunteer it or withhold it on a recall test was .95 (Koriat and Goldsmith, 1996b, Experiment 1; see also Kelley and Sahakyan, 2003). In addition, manipulating the incentives for accurate reporting in the manner described earlier (by manipulating the relative rewards and penalties for correct and incorrect answers, respectively) induced rememberers to adjust their report criterion accordingly; higher levels of confidence were required for reporting answers under a strong accuracy incentive than under a more moderate accuracy incentive (Koriat and Goldsmith, 1996b, Experiment 1; Kelley and Sahakyan, 2003, Experiment 1). Finally, modeling the report decision in terms of a confidence criterion (cutoff), with the level of the criterion for each participant allowed to vary as a free parameter, yielded a very good fit with the data, accounting for about 94% of the participants' actual report decisions under recall testing (Koriat and Goldsmith, 1996b, Experiment 1). Similar levels of fit were found by Kelley and Sahakyan (2003).

The consideration of the role of metacognitive monitoring and control processes in reporting has yielded some interesting insights concerning variables that affect memory accuracy and quantity performance. One, of course, is the effect of accuracy motivation mentioned earlier. A second important variable is monitoring effectiveness, that is, the extent to which the rememberer can distinguish between correct and incorrect answers. On the one hand, as monitoring effectiveness increases, the option of free report allows one to screen out wrong candidate answers without also mistakenly screening out correct candidate answers, thereby reducing the rate of the quantity-accuracy trade-off. On the other hand, when monitoring effectiveness is impaired, the exercise of the option to withhold answers may yield little or no benefit in terms of report accuracy (Koriat and Goldsmith, 1996b; Rhodes and Kelley, 2005; Kelley and Sahakyan, 2003) and may simply reduce the quantity of correct information that is reported (Higham, 2002), compared with forced report.

A third important variable is test format with – recall versus recognition. This variable has been implicated in both traditional, quantity-oriented research and in more naturalistic, accuracy-oriented research, with opposing implications. Whereas the general finding from decades of laboratory research (e.g., Brown, 1976) is that recognition testing is superior to recall testing in eliciting a greater quantity of correct information from memory, the established wisdom in eyewitness research, for example, is that recall is superior to recognition in eliciting accurate information from rememberers (e.g., Hilgard and Loftus, 1979; Neisser, 1988). Koriat and Goldsmith (1994), however, showed that this recall–recognition paradox actually stems from the common confounding between test format (recall vs. recognition) and report option (free vs. forced). Typically, recognition participants are forced either to choose between several alternatives or to make a yes–no decision regarding each and every item, whereas recall participants have the freedom to withhold information that they are unsure about. Comparing performance on a free-recognition test (in which participants had the option to respond 'don't know' to individual items), to a free-recall test, Koriat and Goldsmith (1994) found that recognition quantity performance was still superior to recall, but now recognition accuracy was as high or even higher than recall accuracy. An examination of the underlying memory and metamemory components of recall and recognition performance (*See* Chapter 2.20; Koriat and Goldsmith, 1996b) indicated that monitoring effectiveness was in fact somewhat lower for recognition than for recall testing, but that this disadvantage was more than compensated for by superior memory access and the adoption of a more conservative report criterion under recognition testing.

The consideration of the role of metacognitive monitoring and control processes in reporting has also yielded interesting insights with regard to other important topics and questions, such as developmental changes in memory accuracy (Koriat et al., 2001; Roebers et al., 2001), memory decline in the elderly (Jacoby, 1999; Pansky et al., 2002; Kelley and Sahakyan, 2003; Rhodes and Kelley, 2005), cognitive and metacognitive impairment in schizophrenia (Danion et al., 2001; Koren et al., 2006), psychometric and scholastic testing (Koriat and Goldsmith, 1998; Higham, 2007), and the classic encoding specificity principle (Higham, 2002; Higham and Tam, 2005). As just one example, there has been a question about the reliability of children's memory, particularly in the area of legal testimony, (e.g., Bruck and Ceci, 1999). Yet, Koriat et al. (2001) showed that children as young as 8 or 9 years old can regulate their memory reporting to produce a more accurate record of past events when they are allowed to screen out wrong answers and when they are explicitly motivated to do so. Furthermore, like adults, they are also sensitive to specific levels of accuracy incentive, increasing the accuracy of their reports further when a higher premium is placed on memory accuracy. However, the children in that study (see also Roebers et al., 2001) and elderly adults in other studies (Pansky et al., 2002; Kelley and Sahakyan, 2003; Rhodes and Kelley, 2005) were found to be less effective than young adults in utilizing the option to withhold answers to enhance their accuracy.

Of course, there may be variables whose influences are not amenable to control by way of report regulation. For example, Payne et al. (2004) observed that when participants were allowed the option of free report, they could enhance their overall memory accuracy, but the withholding of answers did not reduce stereotype bias. Their findings suggest that stereotypes distort memory through an unconscious-accessibility bias to which subjective confidence is insensitive. The implication is that any variable that affects memory performance without affecting subjective confidence (i.e., that cannot be monitored) will not be susceptible to report control.

2.18.6.2 Deciding on the Grain Size of the Reported Answer

In addition to the exercise of report option, another means by which rememberers regulate the accuracy and amount of information that they report is controlling the *grain size* of their report, that is, the precision or coarseness of their answers (Yaniv and Foster, 1995, 1997; Goldsmith and Koriat, 1999; Goldsmith et al., 2002, 2005). For example, when asked to specify what time an event occurred, a rememberer who is unsure might provide a relatively coarse response such as "in the late afternoon" or "between 5.00 and 6.00 p.m.," rather than venture a more precise response. In fact, Neisser (1988) observed that, when answering open-ended questions, participants tended to provide answers at a level of generality at which they were "not likely to be mistaken." Of course, more coarsely grained answers, while more likely to be correct, are also less informative. Thus, Goldsmith et al. (2002) proposed that the control of grain size is guided by an accuracy-informativeness trade-off (see also Yaniv and Foster, 1997), similar to the accuracy-quantity trade-off that guides the exercise of report option. They found that, when participants were allowed to control the grain size of their report, they did so in a strategic manner, sacrificing informativeness (precision) for the sake of accuracy when their subjective confidence in the more precise-informative answer was low. The participants also took into account the relative payoffs for accuracy and informativeness in choosing the grain size of their answers; they tended to provide more precise answers (thus taking a greater risk of being wrong) when the relative payoff for informativeness was high than when it was low. The monitoring and control processes involved in the regulation of memory grain size appear to be similar to those underlying the decision to volunteer or withhold specific items of information, implying perhaps the use of common metacognitive mechanisms.

As in the case of report option, a consideration of the control of grain size in memory reporting has begun to shed light on other memory phenomena and issues. One example is the potential role of control over grain size in modulating the changes that occur in memory over time. Goldsmith et al. (2005) examined the regulation of report grain size over different retention intervals. Starting with the well-known finding that people often remember the gist of an event though they have forgotten its details, they asked whether rememberers might exploit the differential forgetting rates of coarse and precise information in regulating the accuracy of the information that they report over time. The results suggested that, when given control over the grain size of their answers, people attempt to maintain a stable level of report accuracy by providing coarser answers at longer retention intervals.

In this section we focused on the control of grain size that takes place at the reporting stage. There is evidence, however, that rememberers can also control the level of coarseness or precision at which they retrieve information (Anderson et al., 2001; Brainerd et al., 2002; Koutstaal, 2003; Koutstaal and Cavendish, 2006). Koutstaal (2003), for example, showed that rememberers can flexibly alternate between attempts to query memory at a highly specific level and attempts to query memory at a categorical level, and that this flexibility is somewhat impaired in older participants. Moreover, Koutstaal and Cavendish (2006) found that initially inducing participants to adopt and use a gist-based retrieval orientation can impair performance on a subsequent memory task that requires a more precise retrieval orientation.

2.18.7 Concluding Remarks

In this chapter, we examined the processes of voluntary remembering that are under the control of the rememberer. Such control is evident throughout the course of remembering, from the initial decision regarding whether and how to begin the memory search, until the final decision regarding how the retrieved information is to be reported. The investigation of self-controlled processes in remembering presents a methodological challenge to students of memory, because such processes are, by definition, less amenable to strict experimental control. Yet, as evidenced by the work reviewed in this chapter, recent years have seen a growing willingness to face this challenge. Clearly, however, much more work needs to be done to illuminate the underlying mechanisms of controlled remembering and clarify the intricate interplay between controlled and automatic memory processes. Ultimately, research should be targeted toward integrating these processes into more general theories of memory and remembering.

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