CHAPTER 11

Metacognition and Consciousness

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Abstract

The study of metacognition can shed light on some fundamental issues about consciousness and its role in behavior. Metacognition research concerns the processes by which people self-reflect on their own cognitive and memory processes (monitoring) and how they put their metaknowledge to use in regulating their information processing and behavior (control). Experimental research on metacognition has addressed the following questions. First, what are the bases of metacognitive judgments that people make in monitoring their learning, remembering, and performance? Second, how valid are such judgments and what are the factors that affect the correspondence between subjective and objective indexes of knowing? Third, what are the processes that underlie the accuracy and inaccuracy of metacognitive judgments? Fourth, how does the output of metacognitive monitoring contribute to the strategic regulation of learning and remembering? Finally, how do the metacognitive processes of monitoring and control affect actual performance? This chapter reviews research addressing these questions, emphasizing its implications for issues concerning consciousness; in particular, the genesis of subjective experience, the function of self-reflective consciousness, and the cause-and-effect relation between subjective experience and behavior.

Introduction

There has been a surge of interest in metacognitive processes in recent years, with the topic of metacognition pulling under one roof researchers from traditionally disparate areas of investigation. These areas include memory research (Kelley & Jacoby, 1998; Metcalfe & Shimamura, 1994; Nelson & Narens, 1990; Reder, 1996), developmental psychology (Schneider & Pressley, 1997), social psychology (Bless & Forgas, 2000; Jost, Kruglanski, & Nelson, 1998; Schwarz, 2004), judgment and decision making (Gilovich, Griffin, & Kahneman, 2002; Winman & Juslin, 2005), neuropsychology (Shimamura, 2000), forensic psychology (e.g., Pansky, Koriat,

& Goldsmith, 2005; Perfect, 2002), educational psychology (Hacker, Dunlosky, & Graesser, 1998), and problem solving and creativity (Davidson & Sternberg, 1998; Metcalfe, 1998a). The establishment of metacognition as a topic of interest in its own right is already producing synergy among different areas of investigation concerned with monitoring and self-regulation (e.g. Fernandez-Duque, Baird, & Posner, 2000). Furthermore, because some of the questions discussed touch upon traditionally ostracized issues in psychology, such as the issues of consciousness and free will (see Nelson, 1996), a lively debate has been going on between metacognitive researchers and philosophers (see Nelson & Rey, 2000). In fact, it appears that the increased interest in metacognition research derives in part from the feeling that perhaps this research can bring us closer to dealing with (certainly not resolving) some of the metatheoretical issues that have been the province of philosophers of the mind.

Definition

Metacognition concerns the study of what people know about cognition in general, and about their own cognitive and memory processes, in particular, and how they put that knowledge to use in regulating their information processing and behavior. Flavell (1971) introduced the term "metamemory," which concerns specifically the monitoring and control of one's learning and remembering. Metamemory is the most researched area in metacognition and is the focus of this chapter.

Nelson and Narens (1990) proposed a conceptual framework that has been adopted by most researchers. According to them, cognitive processes may be divided into those that occur at the object level and those that occur at the meta level: The object level includes the basic operations traditionally subsumed under the rubric of information processing – encoding, rehearsing, retrieving, and so on. The meta level is assumed to oversee object-level operations (monitoring) and return signals to regulate them actively in a top-down fashion (control). The object level, in contrast, has no control over the meta level and no access to it. For example, the study of new material involves a variety of basic, object-level operations, such as text processing, comprehending, rehearsing, and so on. At the same time, metacognitive processes are engaged in planning how to study, in devising and implementing learning strategies, in monitoring the course and success of object-level processes, in modifying them when necessary, and in orchestrating their operation. In the course of studying new material, learners are assumed to monitor their degree of comprehension online and then decide whether to go over the studied material once again, how to allocate time and effort to different segments, and when to end studying.

We should note, however, that the distinction between cognitive and metacognitive processes is not sharp because the same type of cognitive operation may occur at the object level or at the meta level, and in some cases it is unclear to which level a particular operation belongs (Brown, 1987).

Research Traditions

Historically, there have been two main lines of research on metacognition that proceeded almost independently of each other, one within developmental psychology and the other within experimental memory research. The work within developmental psychology was spurred by Flavell (see Flavell, 1979; Flavell & Wellman, 1977), who argued for the critical role that metacognitive processes play in the development of memory functioning (see Flavell, 1999). Within memory research, the study of metacognition was pioneered by Hart's (1965) studies on the feeling-of-knowing (FOK), and Brown and McNeill's (1966) work on the tip-of-the-tongue (TOT).

There is a difference in goals and methodological styles between these two research traditions. The basic assumption among developmental students of metacognition is that learning and memory performance depend heavily on monitoring and regulatory proficiency. This assumption has resulted in attempts to specify the

components of metacognitive abilities, to trace their development with age, and to examine their contribution to memory functioning. Hence a great deal of the work is descriptive and correlational (Schneider, 1985). The focus on age differences and individual differences in metacognitive skills has also engendered interest in specifying "deficiencies" that are characteristic of children at different ages and in devising ways to remedy them. This work has expanded into the educational domain: Because of the increasing awareness of the critical contribution of metacognition to successful learning (Paris & Winograd, 1990), educational programs have been developed (see Scheid, 1993) designed to make the learning process more "metacognitive." Several authors have stressed specifically the importance of metacognition to transfer of learning (see De Corte, 2003).

The conception of metacognition by developmental psychologists is more comprehensive than that underlying much of the experimental work on metacognition. It includes a focus on what children know about the functioning of memory and particularly about one's own memory capacities and limitations. Developmental work has also placed heavy emphasis on strategies of learning and remembering (Bjorklund & Douglas, 1997; Brown, 1987; Pressley, Borkowski, & Schneider, 1987). In addition, many of the issues addressed in the area of theory of mind (Perner & Lang, 1999) concern metacognitive processes. These issues are, perhaps, particularly important for the understanding of children's cognition.

In contrast, the experimental-cognitive study of metacognition has been driven more by an attempt to clarify basic questions about the mechanisms underlying monitoring and control processes in adult memory (for reviews, see Koriat & Levy-Sadot, 1999; Nelson & Narens, 1990; Schwartz, 1994). This attempt has led to the emergence of several theoretical ideas as well as specific experimental paradigms for examining the monitoring and control processes that occur during learning, during the attempt to retrieve information from memory, and following the retrieval of candidate answers (e.g., Metcalfe, 2000; Schwartz, 2002).

In addition to the developmental and the experimental-memory lines of research, there has been considerable work on metacognition in the areas of social psychology and judgment and decision making. Social psychologists have long been concerned with questions about metacognition, although their work has not been explicitly defined as metacognitive (see Jost et al., 1998). In particular, social psychologists share the basic tenets of metacognitive research (see below) regarding the importance of subjective feelings and beliefs, as well as the role of top-down regulation of behavior. In recent years social psychologists have been addressing questions that are at the heart of current research in metacognition (e.g., Winkielman, Schwarz, Fazendeiro, & Reber, 2003; Yzerbyt, Lories, & Dardenne, 1998; see Metcalfe, 1998b). Within the area of judgment and decision making, a great deal of the work concerning the calibration of probability judgments (Fischhoff, 1975; Lichtenstein, Fischhoff, & Phillips, 1982; Winman & Juslin, 2005) is directly relevant to the issues raised in metacognition.

Research Questions

This chapter emphasizes the work on metacognition within the area of adult memory research. It is organized primarily around the five main questions that have been addressed in experimental research on metamemory. First, what are the bases of metacognitive judgments; that is, how do we know that we know (e.g., Koriat & Levy-Sadot, 1999)? Second, how valid are subjective intuitions about one's own knowledge; that is, how accurate are metacognitive judgments, and what are the factors that affect their accuracy (e.g., Schwartz & Metcalfe, 1994)? Third, what are the processes underlying the accuracy and inaccuracy of metacognitive judgments? In particular, what are the processes that lead to illusions of knowing and to dissociations between knowing and the feeling of knowing (e.g., Benjamin & Bjork, 1996; Koriat, 1995)? Fourth, what are the processes underlying the strategic regulation of learning

and remembering? In particular, how does the output of monitoring affect control processes (e.g., Barnes, Nelson, Dunlosky, Mazzoni, & Narens, 1999; Son & Metcalfe, 2000)? Finally, how do the metacognitive processes of monitoring and control affect actual memory performance (e.g., Koriat & Goldsmith, 1996a; Metcalfe & Kornell, 2003)?

Although these questions focus on relatively circumscribed processes of memory and metamemory, they touch upon some of the issues that are at the heart of the notions of consciousness and self-consciousness. Thus, the study of the subjective monitoring of knowledge addresses a defining property of consciousness, because consciousness implies not only that we know something but also that we know that we know it. Thus, consciousness binds together knowledge and metaknowledge (Koriat, 2000b). This idea is implied, for example, in Rosenthal's (2000) "higher-order thought" (HOT) philosophical theory of consciousness: A "lower-order" mental state is conscious by virtue of there being another, higher-order mental state that makes one conscious that one is in the lower-order state (see Chapter 3). Clearly, the subjective feelings that accompany cognitive processes constitute an essential ingredient of conscious awareness. Rather than taking these feelings (and their validity) at their face value, the study of metacognition attempts to uncover the processes that shape subjective feelings and contribute to their validity or to their illusory character. Furthermore, the study of monitoring-based control has implications for the question of the function of conscious awareness, and for the benefits and perils in using one's own intuitive feelings and subjective experience as a guide to judgments and behavior.

Basic Assumptions about Agency and Consciousness

The increased interest in metacognition seems to reflect a general shift from the stimulus-driven, behavioristic view of the person to a view that acknowledges the importance of subjective processes and top-down executive functions (see Koriat, 2000b). The study of metacognition is generally predicated on a view of the person as an active organism that has at its disposal an arsenal of cognitive operations that can be applied at will toward the achievement of various goals. The strategic choice and regulation of these operations are assumed to be guided in part by the person's subjective beliefs and subjective feelings.

Embodied in this view are two metatheoretical assumptions (see Koriat, 2002). The first concerns agency – the assumption that self-controlled processes have measurable effects on behavior. Although most researchers would acknowledge that many cognitive processes, including some that are subsumed under the rubric of executive function, occur outside of consciousness, there is also a recognition that the person is not a mere medium through which information flows. Rather, people have some freedom and flexibility in regulating actively their cognitive processes during learning and remembering. Furthermore, it is assumed that such self-regulation processes deserve to be studied not only because they can have considerable effects on performance but also because they are of interest in their own right.

This assumption presents a dilemma for experimental researchers because self-controlled processes have been traditionally assumed to conflict with the desire of experimenters to exercise strict experimental control. Of course, there are many studies in which learning and remembering strategies have been manipulated (through instructions) and their effects investigated (e.g., Craik & Lockhart, 1972). Unlike such experimenter-induced strategies, however, self-initiated strategies generally have been seen as a nuisance factor that should be avoided or neutralized. For example, laboratory studies typically use a fixed-rate presentation of items rather than a self-paced presentation (see Nelson & Leonesio, 1988). Also, in measuring memory performance, sometimes forced-choice tests are preferred over free-report tests to avoid having to

deal with differences in "guessing," or else some correction for guessing procedure is used to achieve a pure measure of "true" memory (see Koriat & Goldsmith, 1996a; Nelson & Narens, 1994). Needless to say, people in everyday life have great freedom in regulating their memory processes, and the challenge is to find ways to bring these self-controlled metacognitive processes into the laboratory (Koriat, 2000a; Koriat & Goldsmith, 1996a).

The second assumption concerns the role of self-reflective, subjective experience in guiding controlled processes. This is, of course, a debatable issue. It is one thing to equate controlled processes with conscious processes (e.g., Posner & Snyder, 1975); it is another to assume that subjective experience plays a causal role in behavior. Students of metacognition not only place a heavy emphasis on subjective experience but also assume that subjective feelings, such as the feeling of knowing, are not mere epiphenomena, but actually exert a causal role on information processing and behavior (Koriat, 2000b; Nelson, 1996).

A similar growing emphasis on the role of subjective feelings in guiding judgments and behavior can be seen in social-psychological research (Schwarz & Clore, 2003) and in decision making (Slovic, Finucane, Peters, & MacGregor, 2002). Also, the work on memory distortions and false memories brings to the fore the contribution of phenomenological aspects of remembering to source monitoring and reality monitoring (see Kelley & Jacoby, 1998; Koriat, Goldsmith, & Pansky, 2000; Mitchell & Johnson, 2000).

It should be stressed, however, that not all students of metacognition subscribe to the assumptions discussed above. In particular, Reder (1987) has argued that a great deal of strategy selection occurs without conscious deliberation or awareness of the factors that influence one's choice. Of course, there is little doubt that many monitoring and control processes occur without consciousness (Kentridge & Heywood, 2000), so the question becomes one of terminology, like the question whether feelings must be conscious or can also be unconscious (Clore, 1994; Winkielman & Berridge, 2004). However, by and large, much of the experimental research in metacognition is predicated on the tacit assumption that the metacognitive processes studied entail conscious control. Nonetheless, although the term "metacognition" is generally understood as involving conscious awareness, it should be acknowledged that monitoring and control processes can also occur unconsciously (Spehn & Reder, 2000).

I now review some of the experimental work on metamemory, focusing on research that may have some bearing on general questions about phenomenal experience and conscious control.

Experimental Paradigms in the Study of Online Metamemory

A variety of metacognitive judgments have been studied in recent years that ought to be included under the umbrella of metacognition (Metcalfe, 2000). Among these are ease-of-learning judgments (Leonesio & Nelson, 1990), judgments of comprehension (Maki & McGuire, 2002), remember/know judgments (Gardiner, & Richardson-Klavehn, 2000), output monitoring (Koriat, Ben-Zur, & Sheffer, 1988), olfactory metacognition (Jönsson & Olsson, 2003), and source monitoring (Johnson, 1997). However, the bulk of the experimental work has concerned three types of judgments.

First are judgments of learning (JOLs) elicited following the study of each item. For example, after studying each paired-associate in a list, participants are asked to assess the likelihood that they will be able to recall the target word in response to the cue in a future test. These item-by-item judgments are then compared to the actual recall performance.

Second are FOK judgments elicited following blocked recall. In the Recall-Judgment-Recognition (RJR) paradigm introduced by Hart (1965), participants are required to recall items from memory (typically, the answers to general knowledge questions). When they fail to retrieve the answer, they are asked to make FOK

judgments regarding the likelihood that they would be able to select the correct answer from among several distractors in a forced-choice test to be administered later. The validity of FOK judgments is then evaluated by the correspondence between these judgments and performance on the recognition test. Finally, after retrieving an answer from memory or after selecting an answer, the subjective confidence in the correctness of that answer is elicited, typically in the form of a probability judgment reflecting the assessed likelihood that the answer is correct. Whereas JOLs and FOK judgments are prospective, involving predictions of future memory performance, confidence judgments are retrospective, involving assessments about a memory that has been produced.

Many different variations of these general paradigms have been explored, including variations in the type of memory studied (semantic, episodic, autobiographical, eyewitness-type events, etc.), the format of the memory test (free recall, cued recall, forced-choice recognition, etc.), and the particular judgments elicited (item-by-item judgments or global judgments, using a probability or a rating scale, etc.).

How Do We Know That We Know? The Bases of Metacognitive Judgments

As we see later, metacognitive judgments are accurate by and large. JOLs made for different items during study are generally predictive of the accuracy of recalling these items at test. FOK judgments elicited following blocked recall predict the likelihood of recalling or recognizing the elusive target at some later time, and subjective confidence in the correctness of an answer is typically diagnostic of the accuracy of that answer. Thus, the first question that emerges is, How do we know that we know?

This question emerges most sharply with regard to the tip-of-the-tongue (TOT) state, in which we fail to recall a word or a name, and yet we are convinced that we know it and can even sense its imminent emergence into consciousness. What is peculiar about this experience is the discrepancy between subjective and objective knowing. So how can people monitor the presence of information in memory despite their failure to retrieve it? In reviewing the verbal learning literature more than 30 years ago, Tulving and Madigan (1970), in fact, argued that one of the truly unique characteristics of human memory is its knowledge of its own knowledge. They proposed that genuine progress in memory research depends on understanding how the memory system not only can produce a learned response or retrieve an image but also can estimate rather accurately the likelihood of its success in doing it. A great deal of research conducted since 1970 has addressed this question.

The Direct-Access View

A simple answer to the question about the basis of feelings of knowing is provided by the direct-access view according to which people have direct access to memory traces both during learning and during remembering and can base their metacognitive judgments on detecting the presence and/or the strength of these traces. For example, in the case of JOLs elicited during study, it may be proposed that learners can detect directly the memory trace that is formed following learning and can also monitor online the increase in trace strength that occurs in the course of study as more time is spent studying an item (e.g., Cohen, Sandler, & Keglevich, 1991). Of course, to the extent that learners can do so, they can also decide to stop studying (under self-paced conditions) when trace strength has reached a desirable value (Dunlosky & Hertzog, 1998).

A direct-access account has also been advanced by Hart (1965) with regard to FOK. Hart proposed that FOK judgments represent the output of an internal monitor that can survey the contents of memory and can determine whether the trace of a solicited memory target exists in store. Thus, the feeling associated with the TOT state may be assumed to stem from direct

privileged access to the memory trace of the elusive target (see also Burke, MacKay, Worthley, & Wade, 1991; Yaniv & Meyer, 1987). Hart stressed the functional value of having such a monitor, given the general fallibility of the memory system: If the monitor "signals that an item is not in storage, then the system will not continue to expend useless effort and time at retrieval; instead, input can be sought that will put the item into storage" (Hart, 1965; p. 214).

Direct-access (or trace-access) accounts, which assume that monitoring involves a direct readout of information that appears in a ready-made format, have two merits. The first is that they can explain not only the basis of JOLs and FOK judgments but also their accuracy. Clearly, if JOLs are based on accessing the strength of the memory trace that is formed following learning, then they ought to be predictive of future recall, which is also assumed to depend on memory strength. Similarly, if FOK judgments monitor the presence of the memory trace of the unrecalled item, they should be expected to predict the future recognition or recall of that item.

The second merit is that they would seem to capture the phenomenal quality of metacognitive feelings: the subjective feeling, such as that which accompanies the tip-of-the-tongue state, that one monitors directly the presence of the elusive target in memory and its emergence into consciousness (James, 1890). In fact, metacognitive feelings are associated with a sense of self-evidence, which gives the impression that people are in direct contact with the contents of their memories and that their introspections are inherently accurate.

The Cue-Utilization View of Metacognitive Judgments

Although the direct-access view has not been entirely abandoned (see Burke et al., 1991; Metcalfe, 2000), an alternative view has been gaining impetus in recent years. According to this view, metacognitive judgments are inferential in origin, based on a variety of cues and heuristics that have some degree of validity in predicting objective memory performance (Benjamin & Bjork, 1996). To the extent that such indeed is the case, then the accuracy of metacognitive judgments is not guaranteed, but should depend on the validity of the cues on which it rests.

Inferential, cue-utilization accounts generally distinguish between information-based (or theory-based) and experience-based metacognitive judgments (see Kelley & Jacoby, 1996a; Koriat & Levy-Sadot, 1999; Matvey, Dunlosky, & Guttentag, 2001; Strack, 1992). This distinction parallels a distinction between two modes of thought that has been proposed in other domains (see Kahneman, 2003, and see further below). Thus, it is assumed that metacognitive judgments may be based either on a deliberate use of beliefs and memories to reach an educated guess about one's competence and cognitions, or on the application of heuristics that result in a sheer subjective feeling.

Theory-Based Monitoring

Consider first theory-based metacognitive judgments. Developmental students of cognition placed a great deal of emphasis on what Flavell called "metacognitive knowledge;" that is, on children's beliefs and intuitions about their own memory capacities and limitations and about the factors that contribute to memory performance (Brown, 1987). Such beliefs have been found to affect the choice of learning strategies, as well as people's predictions of their own memory performance (see Flavell, 1999; Schneider & Pressley, 1997).

In contrast, the experimental research on adult metacognition contains only scattered references to the possible contribution of theories and beliefs to metacognitive judgments. For example, in discussing the bases of JOLs, Koriat (1997) proposed to distinguish between two classes of cues for theory-based online JOLs, intrinsic and extrinsic. The former includes cues pertaining to the perceived a priori difficulty of the studied items (e.g., Rabinowitz, Ackerman, Craik, & Hinchley, 1982). Such cues seem to affect

JOLs, particularly during the first study trial, as suggested by the observation that normative ratings of ease of learning are predictive both of JOLs and of recall of different items (e.g., Koriat, 1997; Leonesio & Nelson, 1990; Underwood, 1966). The second class includes extrinsic factors that pertain either to the conditions of learning (e.g., number of times an item has been presented, presentation time, etc., Mazzoni, Cornoldi, & Marchitelli, 1990; Zechmeister & Shaughnessy, 1980) or to the encoding operations applied by the learner (e.g., level of processing, interactive imagery, etc.; Begg, Vinski, Frankovich, & Holgate, 1991; Matvey et al., 2001; Rabinowitz et al., 1982; Shaw & Craik, 1989). For example, participants' JOLs seem to draw on the belief that generating a word is better for memory than reading it (Begg et al., 1991; Matvey et al., 2001). Koriat (1997) proposed that JOLs are comparative in nature. Hence, they should be more sensitive to intrinsic cues pertaining to the relative recallability of different items within a list than to factors that affect overall performance (see Begg, Duft, Lalonde, Melnick, & Sanvito, 1989; Carroll, Nelson, & Kirwan, 1997; Shaw & Craik, 1989). Indeed, he obtained evidence indicating that, in making JOLs, the effects of extrinsic factors are discounted relative to those of intrinsic factors that differentiate between different items within a list.

Another major determinant of people's metacognitive judgments is their perceived self-efficacy (Bandura, 1977). In fact, people's preconceived notions about their skills in specific domains predict their assessment of how well they did on a particular task. For example, when students are asked to tell how well they have done on an exam, they tend to overestimate greatly their performance on the test, and this bias derives in part from the tendency of people to base their retrospective assessments on their preconceived, inflated beliefs about their skills in the domain tested, rather than on their specific experience with taking the test (Dunning, Johnson, Ehrlinger, & Kruger, 2003). In a study by Ehrlinger and Dunning (2003), two groups of participants took the same test; those who believed that the test measured abstract reasoning ability (on which they had rated themselves highly) estimated that they had achieved higher scores than did those who thought that they had taken a computer programming test. This was so despite the fact that the two groups did not differ in their actual performance.

Another finding that points to the effects of one's a priori beliefs comes from studies of the relationship between confidence and accuracy. People's confidence in their responses is generally predictive of the accuracy of these responses in the case of general knowledge questions but not in the case of eyewitness memory (Perfect, 2002). Perfect (2004) provided evidence that this occurs because people's confidence is based in part on their preconceptions about their abilities. Such preconceptions are generally valid in the case of general knowledge questions, for which people have had considerable feedback and hence know their relative standing. Such is not the case with eyewitness memory, for which they lack knowledge about how good they are and, by implication, how confident they ought to be. Thus, people's confidence in their performance seems to be based in part on their preconceived beliefs about their own competence in the domain of knowledge tested.

Evidence for the effects of beliefs and theories also comes from studies of correction processes in judgment. People often base their judgments directly on their subjective feelings (see Schwarz & Clore, 1996; Slovic et al., 2002). However, when they realize that their subjective experience has been contaminated by irrelevant factors, they may try to correct their judgments according to their beliefs about how these judgments had been affected by the irrelevant factors (Strack, 1992). For example, in the study of Schwarz, Bless, Strack, Klumpp, Rittenauer-Schatka, and Simons (1991), participants who were asked to recall many past episodes demonstrating self-assertiveness reported lower self-ratings of assertiveness than those who were asked to recall a few such episodes, presumably

because of the greater difficulty experienced in recalling many episodes. However, when led to believe that the experienced difficulty had been caused by background music, participants relied more heavily on the retrieved content, reporting higher ratings under the many-episodes condition than under the few-episodes condition. These and other findings suggest that the correction process is guided by the person's beliefs about the factors that make subjective experience an unrepresentative basis for judgment. Although most researchers assume that the correction process requires some degree of awareness (see Gilbert, 2002), others suggest that it may also occur unconsciously (Oppenheimer, 2004).

More recent work in social cognition (see Schwarz, 2004) suggests that the conclusions that people draw from their metacognitive experience, such as the experience of fluent processing, depend on the naïve theory that they bring to bear. Furthermore, people can be induced to adopt opposite theories about the implications of processing fluency, and these theories modulate experience-based judgments. These suggestions deserve exploration with regard to judgments of one's own knowledge.

Another line of evidence comes from studies that examined how people determine that a certain event did not happen. Strack and Bless (1994) proposed that decisions of nonoccurrence may be based on a metacognitive strategy that is used when rememberers fail to retrieve any feature of a target event that they have judged to be highly memorable. In contrast, in the absence of a clear recollection of a nonmemorable event, people may infer that the event had actually occurred (but had been forgotten). Indeed, non-occurrence decisions are made with strong confidence for events that would be expected to be remembered (e.g., one's name, a salient item, etc.; Brown, Lewis, & Monk, 1977; Ghetti, 2003). On the other hand, studying material under conditions unfavorable for learning (or expecting fast forgetting, Ghetti, 2003) results in a relatively high rate of false alarms for non-memorable distractors. Brainerd, Reyna, Wright, and Mojardin (2003) also discussed a process termed "recollection rejection" in which a distractor that is consistent with the gist of a presented item may be rejected when the verbatim trace of that item is accessed. However, they argued that this process can occur automatically, outside conscious awareness.

The evidence reviewed thus far supports the idea that metacognitive judgments may be based on one's beliefs and theories. For example, the subjective confidence in the correctness of one's memory product (e.g., a selected answer in a quiz) can be based on a logical, analytic process in which one evaluates and weighs the pros and cons (Gigerenzer, Hoffrage & Kleinbölting, 1991; Koriat, Lichtenstein, & Fischhoff, 1980). FOK judgments, too, may draw on theories or beliefs resulting in an educated guess about the likelihood of retrieving or recognizing an elusive word in the future (Costermans, Lories, & Ansay, 1992). Such judgments may not be qualitatively different from many predictions that people make in everyday life.

Experience-Based Monitoring

Experience-based metacognitive judgments, in contrast, are assumed to entail a qualitatively different process from that underlying theory-based judgments. Consider, for example, the TOT experience. The strong conviction that one knows the elusive target is based on a sheer subjective feeling. That feeling, however, appears to be the product of an inferential process that involves the application of nonanalytic heuristics (see Jacoby & Brooks, 1984; Kelley & Jacoby, 1996a; Koriat & Levy-Sadot, 1999) that operate below full consciousness and give rise to a sheer subjective experience. Indeed, the idea that subjective experience can be influenced and shaped by unconscious inferential processes has received support in the work of Jacoby, Kelley, Whittlesea, and their associates (see Kelley & Jacoby, 1998; Whittlesea, 2004). Koriat (1993) argued that the nonanalytic, unconscious basis of metacognitive judgments is responsible for the phenomenal quality of the feeling of knowing

as representing an immediate, unexplained intuition, similar to that which is associated with the experience of perceiving (see Kahneman, 2003). According to this view, sheer subjective experience, which lies at the core of conscious awareness, is in fact the end product of processes that lie below awareness.

Several cues have been proposed as determinants of JOL, FOK, and subjective confidence. These cues have been referred to collectively as "mnemonic" cues (Koriat, 1997). With regard to JOLs and FOK, these cues include the ease or fluency of processing of a presented item (Begg et al., 1989), the familiarity of the cue that serves to probe memory (Metcalfe, Schwartz, & Joaquim, 1993; Reder & Ritter, 1992; Reder & Schunn, 1996), the accessibility of pertinent partial information about a solicited memory target (Dunlosky & Nelson, 1992; Koriat, 1993; Morris, 1990), and the ease with which information comes to mind (Kelley & Lindsay, 1993; Koriat, 1993; Mazzoni & Nelson, 1995). Subjective confidence in the correctness of retrieved information has also been claimed to rest on the ease with which information is accessed and on the effort experienced in reaching a decision (Kelley & Lindsay, 1993; Nelson & Narens, 1990; Robinson & Johnson, 1998; Zakay & Tuvia, 1998).

These cues differ in quality from those underlying theory-based judgments. Whereas the latter judgments draw upon the *content* of domain-specific beliefs and knowledge that are retrieved from memory, the former rely on contentless mnemonic cues that pertain to the quality of processing, in particular, the fluency with which information is encoded and retrieved. As Koriat and Levy-Sadot (1999) argued, "The cues for feelings of knowing, judgments of learning or subjective confidence lie in structural aspects of the information processing system. This system, so to speak, engages in a self-reflective inspection of its own operation and uses the ensuing information as a basis for metacognitive judgments" (p. 496).

Consider experience-based JOLs. These have been claimed to rely on the ease with which the items are encoded during learning or on the ease with which they are retrieved. Both of these types of cues become available in the course of learning and disclose the memorability of the studied material. Such cues have been assumed to give rise to a sheer feeling of knowing. Indeed, there is evidence suggesting that JOLs monitor the ease with which studied items are processed during encoding (Begg, et al., 1989; Koriat, 1997; Matvey et al., 2001). For example, Begg et al. (1989) reported results suggesting that JOLs are sensitive to several attributes of words (e.g., concreteness-abstractness) that affect ease of processing. Other findings suggest that JOLs are affected by the ease and probability with which the to-be-remembered items are retrieved during learning (Benjamin & Bjork, 1996; Benjamin, Bjork, & Schwartz, 1998; Koriat & Ma'ayan, 2005). For example, Hertzog, Dunlosky, Robinson, and Kidder (2003) reported that JOLs increased with the speed with which an interactive image was formed between the cue and the target in a paired-associates task. Similarly, Matvey et al. (2001) found that JOLs increased with increasing speed of generating the targets to the cues at study. These results are consistent with the view that JOLs are based on mnemonic cues pertaining to the fluency of encoding or retrieving to-be-remembered items during study.

With regard to FOK judgments, several heuristic-based accounts have been proposed. According to the *cue familiarity* account, first advanced by Reder (1987; see also Metcalfe et al., 1993), FOK is based on the familiarity of the pointer (e.g., the question, the cue term in a paired-associate, etc., see Koriat & Lieblich, 1977) that serves to probe memory (Reder, 1987). Reder argued that a fast, preretrieval FOK is routinely and automatically made in response to the familiarity of the terms of a memory question to determine whether the solicited answer exists in memory. This preliminary FOK can guide the question answering strategy. Indeed, the latency of speeded FOK judgments was found to be shorter than that of providing an answer. Furthermore, in several studies, the advance priming of the

terms of a question was found to enhance speeded, preliminary FOK judgments without correspondingly increasing the probability of recall or recognition of the answer (Reder, 1987, 1988). Schwartz and Metcalfe (1992) extended Reder's paradigm to show that cue priming also enhances (unspeeded) FOK judgments elicited following recall failure. Additional evidence for the cue-familiarity account comes from studies using a proactive-interference paradigm (Metcalfe et al., 1993). Remarkable support was also obtained using arithmetic problems: When participants made fast judgments whether they knew the answer to an arithmetic problem and could retrieve it, or whether they had to compute it, Know judgments were found to increase with increasing frequency of previous exposures to the same parts of the problem, not with the availability of the answer in memory (Reder & Ritter, 1992). This was true even when participants did not have enough time to retrieve an answer (Schunn, Reder, Nhouyvanisvong, Richards, & Stroffolino, 1997; see Nhouyvanisvong & Reder, 1998, for a review).

Consistent with the cue-familiarity account are also the results of studies of the feeling-of-not-knowing. Glucksberg and McCloskey (1981) and Klin, Guzman, and Levine (1997) reported results suggesting that lack of familiarity can serve as a basis for determining that something is not known. Increasing the familiarity of questions for which participants did not know the answer increased the latency of Don't Know responses as well as the tendency to make a Know response erroneously.

According to the *accessibility* account of FOK, in contrast, FOK is based on the overall accessibility of pertinent information regarding the solicited target (Koriat, 1993). This account assumes that monitoring does not precede retrieval but follows it: It is by trying to retrieve a target from memory that a person can appreciate whether the target is "there" and worth continuing to search for. This occurs because, even when retrieval fails, people may still access a variety of partial clues and activations, such as fragments of the target, semantic and episodic attributes, and so on (see Koriat, Levy-Sadot, Edry, & de Marcas, 2003; Miozzo & Caramazza, 1997). These partial clues may give rise to a sheer feeling that one knows the answer. An important assumption of the accessibility account is that participants have no direct access to the accuracy of the partial clues that come to mind, and therefore both correct and wrong partial clues contribute to the FOK.

Support for the accessibility account comes from a study on the TOT state (Koriat & Lieblich, 1977). An analysis of the questions that tend to induce an overly high FOK suggested that the critical factor is the amount of information they tend to elicit. For example, questions that contain redundancies and repetitions tend to produce inflated feelings of knowing, and so are questions that activate many "neighboring" answers. Thus, accessibility would seem to be a global, unrefined heuristic that responds to the mere amount of information irrespective of its correctness. Because people can rarely specify the source of partial information, they can hardly escape the contaminating effects of irrelevant clues by attributing them to their source. Such irrelevant clues sometimes precipitate a strong illusion of knowing (Koriat, 1995, 1998a) or even an illusory TOT state – reporting a TOT state even in response to questions that have no real answers (Schwartz, 1998), possibly because of the activations that they evoke.

Indeed, Schwartz and Smith (1997) observed that the probability of reporting a TOT state about the name of a fictitious animal increased with the amount of information provided about that animal, even when the amount of information did not contribute to the probability of recalling the name of the animal. In addition, FOK judgments following a commission error (producing a wrong answer) are higher than following an omission error (Koriat, 1995; Krinsky & Nelson, 1985; Nelson & Narens, 1990), suggesting that FOK judgments are sensitive to the mere accessibility of information.

In Koriat's (1993) study, after participants studied a nonsense string, they attempted to

recall as many of the letters as they could and then provided FOK judgments regarding the probability of recognizing the correct string among lures. The more letters that participants could access, the stronger was their FOK regardless of the accuracy of their recall. When the number of letters accessed was held constant, FOK judgments also increased with the ease with which information came to mind, as indexed by recall latency.

If both correct and incorrect partial information contribute equally to the feeling that one knows the elusive memory target, how is it that people can nevertheless monitor their knowledge accurately? According to Koriat (1993) this happens because much of the information that comes spontaneously to mind (around 90%; see Koriat & Goldsmith, 1996a) is correct. Therefore, the total amount of partial information accessible is a good cue for recalling or recognizing the *correct* target. Thus, the accuracy of metamemory is a byproduct of the accuracy of memory: Memory is by and large accurate in the sense that what comes to mind is much more likely to be correct than wrong.

A third account still assumes a combined operation of the familiarity and accessibility heuristics. According to this account both heuristics contribute to FOK, but whereas the effects of familiarity occur early in the microgenesis of FOK judgments, those of accessibility occur later, and only when cue familiarity is sufficiently high to drive the interrogation of memory for potential answers (Koriat, & Levy-Sadot, 2001; Vernon & Usher, 2003). This account assumes that familiarity, in addition to affecting FOK judgments directly, also serves as a gating mechanism: When familiarity is high, participants probe their memory for the answer, and then the amount of information accessible affects memory performance. When familiarity is low, the effects of potential accessibility on FOK are more limited.

It should be noted, however, that results obtained by Schreiber and Nelson (1998) question the idea that FOK judgments are sensitive to the mere accessibility of partial clues about the target. These results indicate that FOK decreases with the number of pre-experimental, neighboring concepts that are linked to a cue, suggesting that these judgments are sensitive to the competition between the activated elements.

Subjective confidence in the correctness of one's answers has also been assumed to rest sometimes on mnemonic cues deriving from the process of recalling or selecting an answer. Thus, people express stronger confidence in the answers that they retrieve more quickly, whether those answers are correct or incorrect (Nelson & Narens, 1990). Similarly, in a study by Kelley and Lindsay (1993), retrieval fluency was manipulated through priming. Participants were asked to answer general information questions and to indicate their confidence in the correctness of their answers. Prior to this task, participants were asked to read a series of words, some of which were correct answers and some were plausible but incorrect answers to the questions. This prior exposure was found to increase the speed and probability with which those answers were provided in the recall test and, in parallel, to enhance the confidence in the correctness of those answers. Importantly, these effects were observed for both correct and incorrect answers. These results support the view that retrospective confidence is based in part on a simple heuristic: Answers that come to mind easily are more likely to be correct than those that take longer to retrieve.

The imagination inflation effect also illustrates the heuristic basis of confidence judgments. Asking participants to imagine some childhood events increased confidence that these events did indeed happen in the past (Garry, Manning, Loftus, & Sherman, 1996). Merely asking about the event twice also increased subjective confidence. Possibly imagination of an event and attempting to recall it increase its retrieval fluency, which in turn contributes to the confidence that the event has occurred (see also Hastie, Landsman & Loftus, 1978).

In sum, although metacognitive judgments may be based on explicit inferences that draw upon a priori beliefs and knowledge, much of the recent evidence points to

the heuristic basis of such judgments, suggesting that feelings of knowing are based on the application of nonanalytic heuristics that operate below conscious awareness. These heuristics rely on mnemonic cues pertaining to the quality of processing and result in a sheer noetic experience. Thus, it would seem that sheer subjective feelings, such as the feeling of knowing, which are at the core of subjective awareness, are the product of unconscious processes (Koriat, 2000b).

The distinction between information-based and experience-based processes has important implications that extend beyond metacognition. It shares some features with the old distinction between reason and emotion (see Damasio, 1994), but differs from it. It implies a separation between two components or states of consciousness – on the one hand, sheer subjective feelings and intuitions that have a perceptual-like quality and, on the other hand, reasoned cognitions that are grounded in a network of beliefs and explicit memories. It is a distinction between what one "feels" and "senses" and what one "knows" or "thinks." The extensive research in both cognitive psychology and social psychology (e.g., Jacoby & Whitehouse, 1989; Strack, 1992) indicates that these two components of conscious awareness are not only dissociable, but may actually conflict with each other, pulling judgments and behavior in opposite directions (Denes-Raj & Epstein, 1994). The conflict between these components is best illustrated in correction phenomena (e.g., Jacoby & Whitehouse, 1989; Strack, 1992), which suggest that when people realize that their subjective experience has been contaminated, they tend to change their judgments so as to correct for the assumed effects of that contamination (Strack, 1992).

Dissociations between Knowing and the Feeling of Knowing

The clearest evidence in support of the idea that metacognitive judgments are based on inference from cues rather than on direct access to memory traces comes from observations documenting a dissociation between subjective and objective indexes of knowing. Several such dissociations have been reported. These dissociations also bring to the fore the effects of specific mnemonic cues on metacognitive judgments.

With regard to JOLs, Begg et al. (1989) found that high-frequency words, presumably fluently processed, yielded higher JOLs but poorer recognition memory than low-frequency words (see also Benjamin, 2003). Narens, Jameson and Lee (1994) reported that subthreshold target priming enhanced JOLs, perhaps because it facilitated the processing of the target, although it did not affect eventual recall.

Bjork (1999) described several conditions of learning that enhance performance during learning but impair long-term retention and/or transfer. According to Bjork and Bjork (1992), these manipulations facilitate "retrieval strength" but not "storage strength." As a result, the learners, fooled by their own performance during learning, may experience an illusion of competence, resulting in inflated predictions about their future performance. For example, massed practice typically yields better performance than spaced practice in the short term, whereas spaced practice yields considerably better performance than massed practice in the long term. Massed practice, then, has the potential of leading learners to overestimate their future performance. Indeed, Zechmeister and Shaughnessy (1980) found that words presented twice produced higher JOLs when their presentation was massed than when it was distributed, although the reverse pattern was observed for recall. A similar pattern was reported by Simon and Bjork (2001) using a motor-learning task: Participants asked to learn each of several movement patterns under blocked conditions predicted better performance than when those patterns were learned under random (interleaved) conditions, whereas actual performance exhibited the opposite pattern.

Benjamin et al. (1998) reported several experiments documenting a negative

relation between recall predictions and actual recall performance, presumably deriving from reliance on retrieval fluency when retrieval fluency was a misleading cue for future recall. For example, they had participants answer general information questions and assess the likelihood that they would be able to free recall each answer in a later test. The more rapidly participants retrieved an answer to a question, the higher was their estimate that they would be able to free recall that answer at a later time. In reality, however, the opposite was the case.

Another type of dissociation was reported by Koriat, Bjork, Sheffer, and Bar (2004). They speculated that, to the extent that JOLs are based on processing fluency at the time of study, they should be insensitive to the expected time of testing. This should be the case because the processing fluency of an item at the time of encoding should not be affected by when testing is expected. Indeed, when participants made JOLs for tests that were expected either immediately after study, a day after study, or a week after study, JOLs were entirely indifferent to the expected retention interval, although actual recall exhibited a typical forgetting function. This pattern resulted in a dissociation such that predicted recall matched actual recall very closely for immediate testing. For a week's delay, however, participants predicted over 50% recall, whereas actual recall was less than 20%.

That study also demonstrated the importance of distinguishing between experience-based and theory-based JOLs: When a new group of participants were presented with all three retention intervals and asked to estimate how many words they would recall at each interval, their estimates closely mimicked the forgetting function exhibited by the first group's actual recall. Thus, the effects of forgetting on recall performance seem to emerge under conditions that activate participants' beliefs about memory.

Dissociations have also been reported between FOK judgments and actual memory performance. First are the findings in support of the cue-familiarity account reviewed above. These findings indicate that manipulations that enhance the familiarity of the terms of a question enhance FOK judgments associated with that question without correspondingly affecting actual recall performance. A similar dissociation, inspired by the accessibility account, has been demonstrated by Koriat (1995): The results of that study suggest that FOK judgments for general information questions tend to be accurate as long as these questions bring to mind more correct than incorrect partial information. However, deceptive questions (Fischhoff, Slovic, & Lichtenstein, 1977), which bring to mind more incorrect than correct information, produce unduly high FOK judgments following recall failure and, in fact, yield a dissociation to the extent that FOK judgments are *negatively* correlated with subsequent recognition memory performance.

With regard to confidence judgments, Chandler (1994) presented participants with a series of target and non-target stimuli, each consisting of a scenic nature picture. In a subsequent recognition memory test, a dissociation was observed such that targets for which there existed a similar stimulus in the non-target series were recognized less often, but were endorsed with stronger confidence than targets for which no similar non-target counterpart was included. Thus, seeing a related target seems to impair memory while enhancing confidence.

Busey, Tunnicliff, Loftus, and Loftus (2000) had participants study a series of faces appearing at different luminance conditions. For faces that had been studied in a dim condition, testing in a bright condition reduced recognition accuracy, but increased confidence, possibly because it enhanced their fluent processing during testing.

In sum, several researchers, motivated by the cue-utilization view of metacognitive judgments, have deliberately searched for conditions that produce a dissociation between memory and metamemory. Interestingly, all of the manipulations explored act in one direction: inflating metacognitive judgments relative to actual memory performance. Some of the experimental

conditions found to engender illusions of knowing are ecologically unrepresentative, even contrived. However, the demonstrated dissociations clearly speak against the notion that metacognitive judgments rest on privileged access to the contents of one's own memory.

The Validity of Metacognitive Judgments

How valid are subjective feelings of knowing in monitoring actual knowledge? How accurate are people's introspections about their memory? Earlier research has sought to establish a correspondence between knowing and the feeling of knowing as an attempt to support the trace-access view of metacognitive judgments. Later studies, in contrast, inspired by the inferential view, have concentrated on producing evidence for miscorrespondence and dissociation, as just reviewed. Although the conditions used in these studies may not be ecologically representative, the results nevertheless suggest that the accuracy of metacognitive judgments is limited. Furthermore, these results point to the need to clarify the reasons for accuracy and inaccuracy and to specify the conditions that affect the degree of correspondence between subjective and objective measures of knowing.

Two aspects of metacognitive accuracy must be distinguished. The first is calibration (Lichtenstein et al., 1982) or "bias" or "absolute accuracy" (see Nelson & Dunlosky, 1991), which refers to the correspondence between mean metacognitive judgments and mean actual memory performance and reflects the extent to which metacognitive judgments are realistic. For example, if confidence judgments are elicited in terms of probabilities, then the mean probability assigned to all the answers in a list is compared to the proportion of correct answers. This comparison can indicate whether probability judgments are well calibrated or whether they disclose an overconfidence bias (inflated confidence relative to performance) or an underconfidence bias. Calibration or bias can also be assessed by eliciting global or aggregate predictions (Hertzog, Kidder, Powell-Moman, & Dunlosky 2002; Koriat, Sheffer, & Ma'ayan, 2002; Liberman, 2004), for example, by asking participants to estimate how many answers they got right and comparing that estimate to the actual number of correct answers.

It should be stressed that calibration can be evaluated only when judgments and performance are measured on equivalent scales. Thus, for example, if confidence judgments are made on a rating scale, calibration cannot be evaluated unless some assumptions are made (e.g., Mazzoni & Nelson, 1995).

Such is not the case for the second aspect of metacognitive accuracy, resolution (or relative accuracy). Resolution refers to the extent to which metacognitive judgments are correlated with memory performance across items. This aspect is commonly indexed by a within-subject gamma correlation between judgments and performance (Nelson, 1984). For example, in the case of JOLs and FOK judgments, resolution reflects the extent to which a participant can discriminate between items that she will recall and those that she will not. In the case of confidence, it reflects the ability to discriminate between correct and incorrect answers.

The distinction between calibration and resolution is important. For example, in monitoring one's own competence during the preparation for an exam, calibration is pertinent to the decision when to stop studying: Overconfidence may lead to spending less time and effort than are actually needed. Resolution, in turn, is relevant to the decision how to allocate the time between different parts of the material. Importantly, resolution can be high, even perfect, when calibration is very poor. Also, calibration and resolution may be affected differentially. For example, Koriat et al. (2002) observed that practice studying the same list of items improves resolution but impairs calibration, instilling underconfidence.

We should note that much of the experimental work on the accuracy of JOLs and

FOK judgments has focused on resolution. In contrast, research on confidence judgments, primarily the work carried out within the judgment and decision tradition, has concentrated on calibration.

With regard to JOLs elicited during study, the results of several investigations indicate that by and large item-by-item JOLs are well calibrated on the first study-test trial (e.g., Dunlosky & Nelson, 1994; Mazzoni & Nelson, 1995). Judgments of comprehension, in contrast, tend to be very inflated. One reason for this is that in monitoring comprehension people assess familiarity with the general domain of the text instead of assessing knowledge gained from that text (Glenberg, Sanocki, Epstein, & Morris, 1987).

Two interesting trends have been reported with regard to the calibration of JOLs. First is the aggregate effect. When learners are asked to provide an aggregate judgment (i.e., predict how many items they will recall), their estimates, when transformed into percentages, are substantially lower than item-by-item judgments. Whereas the latter judgments tend to be relatively well calibrated or even slightly inflated, aggregate judgments tend to yield underconfidence (Koriat et al., 2002, 2004; Mazzoni & Nelson, 1995). A similar effect has been observed for confidence judgments (Griffin & Tversky, 1992).

Second is the underconfidence-with-practice (UWP) effect (Koriat et al., 2002): When learners are presented with the same list of items for several study-test cycles, their JOLs exhibit relatively good calibration on the first cycle, with a tendency toward overconfidence. However, a shift toward marked underconfidence occurs from the second cycle on. The UWP effect was found to be very robust across several experimental manipulations and was obtained even for a task involving the monitoring of memory for self-performed tasks.

Turning next to resolution, the within-person correlation between JOLs and subsequent memory performance tends to be relatively low, particularly when the studied material is homogeneous. For example, the JOL-recall gamma correlation averaged .54 across several studies that used lists of paired-associates that included related and unrelated pairs (Koriat et al., 2002). In contrast, in Dunlosky and Nelson's (1994) study, in which all pairs were unrelated, the gamma correlation averaged .20.

Monitoring seems to be particularly poor when it concerns one's own actions. When participants are asked to perform a series of minitasks (so called self-performed tasks) and to judge the likelihood of recalling these tasks in the future, the accuracy of their predictions is poor, and much lower than that for the study of a list of words (Cohen et al., 1991). It has been argued that people sometimes have special difficulties in monitoring their own actions (e.g., Koriat, Ben-Zur, & Druch, 1991).

However, two types of procedures have been found to improve JOL resolution. The first procedure is repeated practice studying the same list of items. As noted earlier, although repeated practice impairs calibration, it does improve resolution (King, Zechmeister, & Shaughnessy, 1980; Koriat, 2002; Mazzoni et al., 1990). Thus, in Koriat et al.'s (2002) analysis, in which the JOL-recall gamma correlation averaged .54 for the first study-test cycle, that correlation reached .82 on the third study-test cycle. Koriat (1997) produced evidence suggesting that the improved resolution with practice occurs because (a) with increased practice studying a list of items, the basis of JOLs changes from reliance on pre-experimental intrinsic attributes of the items (e.g., perceived difficulty) toward a greater reliance on mnemonic cues (e.g., processing fluency) associated with the study of these items, and (b) mnemonic cues tend to have greater validity than intrinsic cues, being sensitive to the immediate processing of the items during study. Rawson, Dunlosky, and Thiede (2000) also observed an improvement in judgments of comprehension with repeated reading trials.

A second procedure that proved effective in improving JOL accuracy is that of soliciting JOLs not immediately after studying each item, but a few trials later.

In paired-associate learning, delaying JOLs has been found to enhance JOL accuracy markedly (Dunlosky & Nelson, 1994; Nelson & Dunlosky, 1991). However, the delayed-JOL effect occurs only when JOLs are cued by the stimulus term of a paired-associate, not when cued by an intact stimulus-response pair (Dunlosky & Nelson, 1992). It would seem that the condition in which JOLs are delayed and cued by the stimulus alone approximates the eventual criterion test, which requires access to information in long-term memory in response to a cue. Indeed, Nelson, Narens, and Dunlosky (2004) reported evidence suggesting that, in making delayed JOLs, learners rely heavily on the accessibility of the target, which is an effective predictor of subsequent recall. When JOLs are solicited immediately after study, the target is practically always retrievable, and hence its accessibility has little diagnostic value. There is still controversy, however, whether the delayed-JOL effect indeed reflects improved metamemory (Dunlosky & Nelson, 1992) or improved memory (Kimball & Metcalfe, 2003; Spellman & Bjork, 1992).

Koriat and Ma'ayan (2005) reported evidence suggesting that the basis of JOLs changes with delay: As the solicitation of JOLs is increasingly delayed, a shift occurs in the basis of JOLs from reliance on encoding fluency (the ease with which an item is committed to memory) toward greater reliance on retrieval fluency (the ease with which the target comes to mind in response to the cue). In parallel, the validity of retrieval fluency in predicting recall increases with delay and becomes much better than that of encoding fluency. These results suggest that metacognitive judgments may be based on the flexible and adaptive utilization of different mnemonic cues according to their relative validity in predicting memory performance.

The results of Koriat and Ma'ayan suggest that repeated practice and delay may contribute to JOL accuracy by helping learners overcome biases that are inherent in encoding fluency. Koriat and Bjork (2005) described an illusion of competence – *foresight bias* – that arises from an inherent discrepancy between the standard conditions of learning and the standard conditions of testing. On a typical memory test, people are presented with a question and are asked to produce the answer. In contrast, in the corresponding learning condition, both the question and the answer generally appear in conjunction, meaning that the assessment of one's future memory performance occurs in the presence of the answer. This difference has the potential of creating unduly high feelings of competence that derive from the failure to discount what one now knows. This situation is similar to what has been referred to as the "curse of knowledge" – the difficulty in discounting one's privileged knowledge in judging what a more ignorant other knows (Birch & Bloom, 2003). Koriat and Bjork produced evidence suggesting that learners are particularly prone to a foresight bias in paired-associate cue-target learning when the target (present during study) brings to the fore aspects of the cue that are less apparent when the cue is later presented alone (at test). Subsequent experiments (Koriat & Bjork, 2006) indicated that foresight bias, and associated overconfidence, can be alleviated by conditions that enhance learners' sensitivity to mnemonic cues that pertain to the testing situation, including study-test experience, particularly test experience, and delaying JOLs.

Another way in which JOLs can be made more sensitive to the processes that affect performance during testing was explored by Guttentag and Carroll (1998) and Benjamin (2003). They obtained the typical result in which learners predict superior recognition memory performance for common than for uncommon words (although in reality the opposite is the case). However, when during the recognition test learners made postdictions about the words that they could not remember (i.e., judged the likelihood that they would have recognized the word if they had studied it), they actually postdicted superior recognition of the uncommon words. Furthermore, the act of making postdictions for one list of items was found to rectify predictions made for a second list of items studied later.

As far as the accuracy of FOK judgments is concerned, these judgments are relatively well calibrated (Koriat, 1993) and are moderately predictive of future recall and recognition. Thus, participants unable to retrieve a solicited item from memory can estimate with above-chance success whether they will be able to recall it in the future, produce it in response to clues, or identify it among distractors (e.g., Gruneberg & Monks, 1974; Hart, 1967). In a meta-analysis, Schwartz and Metcalfe (1994) found that the accuracy of FOK judgments in predicting subsequent recognition performance increases with the number of test alternatives. The highest correlations were found when the criterion test was recall.

Assuming that metacognitive judgments are based on internal, mnemonic cues, then their accuracy should depend on the validity of the cues on which they rest. However, only a few studies examined the validity of the mnemonic cues that are assumed to underlie FOK judgments. Koriat (1993) showed that the correlation between the amount of partial information retrieved about a memory target (regardless of its accuracy) is a good predictor of eventual memory performance, and its validity is equal to that of FOK judgments. Whereas the overall accessibility of information about a target (inferred from the responses of one group of participants) predicted the magnitude of FOK judgments following recall failure, the output-bound accuracy of that information was predictive of the accuracy (resolution) of these FOK judgments (Koriat, 1995). In a similar manner, cue familiarity may contribute to the accuracy of FOK judgments because in the real world cues and targets (or questions and answers) typically occur in tight conjunction; therefore familiarity with the clue should predict familiarity with the target (Metcalfe, 2000).

Turning finally to retrospective confidence judgments, these have received a great deal of research in the area of judgment and decision making. When participants are presented with general knowledge questions and are asked to assess the probability that the chosen answer is correct, an overconfidence bias is typically observed, with mean probability judgments markedly exceeding the proportion of correct answers (Lichtenstein et al., 1982). This overconfidence has been claimed to derive from a confirmation bias (see Koriat et al., 1980; Nickerson, 1998; Trope & Liberman, 1996) – the tendency to build toward a conclusion that has already been reached by selectively gathering or utilizing evidence that supports that conclusion. However, it has also been argued that part of the observed overconfidence may be due to the biased sampling of items by researchers – the tendency to include too many deceptive items. Indeed, when items are drawn randomly, the overconfidence bias decreases or disappears (Gigerenzer et al., 1991).

More recently, attempts have been made to show that confidence in a decision is based on the sampling of events from memory, with overconfidence resulting from a biased sampling (Winman & Juslin, 2005). Indeed, Fiedler and his associates (Fiedler, Brinkmann, Betsch, & Wild, 2000; Freytag & Fiedler, 2006) used a sampling approach to explain several biases in judgment and decision making in terms of the notion of *metacognitive myopia*. According to this approach, many environmental entities have to be inferred from the information given in a sample of stimulus input. Because samples are rarely representative, an important metacognitive requirement would be to monitor sampling biases and control for them. People's responses, however, are finely tuned to the information given in the sample, and biased judgments, including overconfidence, derive from the failure to consider the constraints imposed on the generation of the information sample.

It is important to note that overconfidence is not ubiquitous: When it comes to sensory discriminations, participants exhibit underconfidence, thinking that they did worse than they actually did (Björkman, Juslin, & Winman, 1993). Also, whereas item-by-item confidence judgments yield overconfidence, aggregate (or global) judgments (estimating the number of correct answers), as noted earlier, typically yield underconfidence (Gigerenzer et al., 1991; Griffin & Tversky, 1992). The

underconfidence for aggregate judgments may derive in part from a failure to make an allowance for correct answers likely to result from mere guessing (Liberman, 2004).

A great deal of research has been carried out also on the confidence-accuracy (C-A) relation, with variable results. The general pattern that emerges from this research is that the C-A relation is quite strong when calculated within each participant (which is what was referred to as resolution), but very weak when calculated between participants (see Perfect, 2004). Consider the latter situation first. Research conducted in the domain of eyewitness testimony, focusing on the ability of participants to recall a particular detail from a crime or to identify the perpetrator in a lineup, has yielded low C-A correlations (Wells & Murray, 1984). That research has typically focused on a between-individual analysis, which is, perhaps, particularly relevant in a forensic context: It is important to know whether eyewitnesses can be trusted better when they are confident in the testimony than when they express low confidence. Similarly, if there are several witnesses, it is important to know whether the more confident among them is likely to be the more accurate. Thus, in this context the general finding is that a person's confidence in his or her memory is a poor predictor of the accuracy of that memory.

On the other hand, research focusing on within-person variation has typically yielded moderate-to-high C-A correlations. Thus, when participants answer a number of questions and for each question report their confidence in the correctness of the answer, the cross-item correlation between confidence and accuracy tends to be relatively high (e.g. Koriat & Goldsmith, 1996a). The same is true when the questions concern the episodic memory for a previously experienced event (Koriat, Goldsmith, Schneider, & Nakash-Dura, 2001). Thus, people can generally discriminate between answers (or memory reports) that are likely to be correct and those that are likely to be false.

Why are the between-participant correlations very low? Several studies suggest that these low correlations stem from the low level of variability among witnesses in experimental laboratory studies. Such studies typically maintain the same conditions across participants. In contrast, under naturalistic conditions the correlation is generally much higher, and it is that type of correlation that would seem to be of relevance in a forensic context (Lindsay, Read & Sharma, 1998). A second reason, mentioned earlier, is that retrospective confidence judgments tend to be based in part on participants' preconceptions about their ability in the domain tested, and these preconceptions tend to be of low validity when they concern eyewitness memory (e.g., lineup identification).

Several studies explored the subjective mnemonic cues that may mediate the within-person C-A correlation. These cues include retrieval latency and the perception of effortless retrieval. The correlation was higher for recall than for recognition presumably because recall provides more cues pertaining to ease of retrieval than recognition (Koriat & Goldsmith, 1996a; Robinson, Johnson, & Herndon, 1997). Robinson, Johnson, & Robertson (2000) found that ratings of vividness and detail for a videotaped event contributed more strongly to confidence judgments than processing fluency and were also more diagnostic of memory accuracy. Attempts to enhance the C-A relation in eyewitness identification by inducing greater awareness of the thoughts and reasoning process involved in the decision process have been largely ineffective or even counterproductive (Robinson & Johnson, 1998).

In sum, the accuracy of metacognitive judgments has attracted a great deal of interest because of its theoretical and practical implications. The results are quite variable, although by and large JOLs, FOK judgments, and confidence ratings are moderately predictive of item differences in actual memory performance.

The Control Function of Metacognition

As noted earlier, much of the work in metacognition is predicated on the assumption

that consciousness is not a mere epiphenomenon. Rather, subjective feelings and subjective judgments exert a causal role on behavior. In metacognition research this idea has been expressed in terms of the hypothesis that monitoring affects control (Nelson, 1996). Indeed, several observations suggest a causal link between monitoring and control so that the output of monitoring serves to guide the regulation of control processes.

With regard to the online regulation of learning, it has been proposed that JOLs affect the choice of which items to relearn and how much time to allocate to each item. Indeed, it has been observed that under self-paced conditions, when learners are given the freedom to regulate the amount of time spent on each item, they tend to allocate more time to items that are judged to be difficult to learn than to those that are judged to be easier (for a review see Son & Metcalfe, 2000). It was proposed that the effects of item difficulty on study time allocation are mediated by a monitoring process in which learners judge the difficulty of each item and then invest more effort in studying the judged-difficult items to compensate for their difficulty (Nelson & Leonesio, 1988).

Dunlosky and Hertzog (1998; see also Thiede & Dunlosky, 1999) proposed a discrepancy-reduction model to describe the relation between JOLs and study time allocation. Learners are assumed to monitor online the increase in encoding strength that occurs as more time is spent studying an item and to cease study when a desired level of strength has been reached. This level, which is referred to as "norm of study" (Le Ny, Denhiere, & Le Taillanter, 1972), is preset on the basis of various motivational factors, such as the stress on accurate learning versus fast learning (Nelson & Leonesio, 1988). Thus, in self-paced learning, study continues until the perceived degree of learning meets or exceeds the norm of study.

In their review of the literature, Son and Metcalfe (2000) found that indeed, in 35 of 46 published experimental conditions, learners exhibited a clear preference for studying the more difficult materials. There are two exceptions to this rule, however. First, Thiede and Dunlosky (1999) showed that when learners are presented with an easy goal (e.g., to learn a list of 30 items with the aim of recalling at least 10 of them), they tended to choose the easier rather than the more difficult items for restudy. Thiede and Dunlosky took these results to imply a hierarchy of control levels: At a superordinate level, learners may plan to invest more effort studying either the easier or the more difficult items. This strategy is then implemented at the subordinate level to control the amount of time allocated to each item and to select items for restudy.

Second, Son and Metcalfe (2000) had participants learn relatively difficult materials with the option to go back to materials that had previously been studied. Under high time pressure, participants allocated more study time to materials that were judged as easy and interesting. When the time pressure was not so great, however, they tended to focus on the more difficult items.

These results indicate that study time allocation is also affected by factors other than the output of online monitoring. Indeed, other studies indicated, for example, that learners invest more study time when they expect a recall test than when they expect a recognition test (Mazzoni & Cornoldi, 1993) and when the instructions stress memory accuracy than when they stress speed of learning (Nelson & Leonesio, 1988). Also, the allocation of study time to a given item varies according to the incentive for subsequently recalling that item and according to the expected likelihood that the item would be later tested (Dunlosky & Thiede, 1998).

Altogether, these results suggest that study time allocation is guided by an adaptive strategy designed to minimize effort and improve learning.

With regard to FOK judgments, several studies indicated that they predict how long people continue searching for a memory target before giving up: When people feel that they know the answer or that the answer is on the tip-of-the-tongue, they search longer than when they feel that they do not know the answer (Barnes et al., 1999; Costermans

et al., 1992; Gruneberg, Monks, & Sykes, 1977; Schwartz, 2001). FOK judgments are also predictive of the speed of retrieving an answer, so that in the case of commission responses the correlation between FOK judgments and retrieval latency is positive, whereas for omission responses the correlation between FOK and the latency of the decision to end search is negative (see Nelson & Narens, 1990).

Search time is also affected by other factors in addition to FOK judgments: When participants are penalized for slow responding, they tend to retrieve answers faster but produce more incorrect answers (Barnes et al., 1999).

As noted earlier, Reder (1987) proposed that preliminary FOK judgments also guide the selection of strategies for solving problems and answering questions. In her studies, the decision whether to retrieve a solution to an arithmetic problem (Know) or to compute it was affected by manipulations assumed to influence cue familiarity. These studies suggest that FOK judgments that are misled by cue familiarity can misguide the decision to retrieve or compute the answer.

Retrospective monitoring can also affect behavior. When people make an error in performing a task they can detect that without an external feedback and can often immediately correct their response. Following the detection of an error, people tend to adjust their speed of responding to achieve a desirable level of accuracy (Rabbit, 1966).

Confidence judgments have also been shown to affect choice and behavior and do so irrespective of their accuracy. As noted earlier, people are often overconfident in their knowledge. Fischhoff et al. (1977) showed that people had sufficient faith in their confidence judgments that they were willing to stake money on their validity.

Consider the finding, mentioned earlier, that when judging how well they have done on a test, people tend to base their judgments on their preconceptions about their abilities in the domain tested. Ehrlinger and Dunning (2003) reasoned that because women tend to perceive themselves as less scientifically talented than men, they should be expected to rate their performance on a quiz of scientific reasoning lower than men rate themselves. Such was indeed the case, although in reality there was no gender difference in actual performance. When asked later if they would like to participate in a science competition, women were more likely to decline, and their reluctance correlated significantly with their self-rated performance on the quiz. Thus, their choices were affected by their confidence even when confidence was unrelated to actual performance.

A systematic examination of the control function of confidence judgments was conducted by Koriat and Goldsmith (1994, 1996a,b) in their investigation of the strategic regulation of memory accuracy. Consider the situation of a person on the witness stand who is sworn to "tell the whole truth and nothing but the truth." To meet this requirement, that person should monitor the accuracy of every piece of information that comes to mind before deciding whether to report it or not. Koriat and Goldsmith proposed a model that describes the monitoring and control processes involved. The rememberer is assumed to monitor the subjective likelihood that each candidate memory response is correct and then compare that likelihood to a preset threshold on the monitoring output to determine whether to volunteer that response or not. The setting of the control threshold depends on the relative utility of providing as complete a report as possible versus as accurate a report as possible. Several results provided consistent support for this model. First, the tendency to report an answer was very strongly correlated with subjective confidence in the correctness of the answer (the intra-subject gamma correlations averaged more than .95; Koriat & Goldsmith, 1996b, Experiment 1; see also Kelley & Sahakyan, 2003). This result suggests that people rely completely on their subjective confidence in deciding whether to volunteer an answer or withhold it. In fact, participants were found to rely heavily on their subjective confidence even when answering a set of "deceptive" general knowledge questions, for which subjective confidence was quite undiagnostic

of accuracy (Koriat & Goldsmith, 1996b, Experiment 2). Second, participants given a high accuracy incentive (e.g., "you win one point for each correct answer but lose all of your winnings if even a single answer is incorrect") adopted a stricter criterion than participants given a more moderate incentive (a 1:1 penalty-to-bonus ratio), suggesting that the strategic regulation of memory reporting is flexibly adapted to the emphasis on memory accuracy. Third, the option to volunteer or withhold responses (which is often denied in traditional memory experiments) allowed participants to boost the accuracy of what they reported, in comparison with a forced-report test. This increase occurred by sacrificing some of the correct answers; that is, at the expense of memory quantity performance. This implies that eyewitnesses generally cannot "tell the whole truth" and also "tell nothing but the truth," but must find a compromise between the two requirements. Importantly, however, the extent of the quantity-accuracy tradeoff was shown to depend critically on monitoring effectiveness: In fact, when monitoring resolution is very high (that is, when a person can accurately discriminate between correct and wrong answers), the accuracy of what is reported may be improved significantly under free report conditions at little or no cost in quantity performance. Thus, in the extreme case when monitoring is perfect, a person should be able to exercise a perfect screening process, volunteering all correct items of information that come to mind and withholding all incorrect items.

Koriat and Goldsmith's model was applied to study the strategic regulation of memory accuracy by school-aged children (Koriat et al., 2001). Even second-to-third-grade children were effective in enhancing the accuracy of their testimony when given the freedom to volunteer or withhold an answer under a 1:1 penalty-to-bonus ratio, and they were able to enhance the accuracy of their reports even further when given stronger incentives for accurate reporting. However, both the children in this study (see also Roebers, Moga, & Schneider, 2001) and elderly adults in other studies (Kelley & Sahakyan, 2003; Pansky, Koriat, Goldsmith, & Pearlman-Avnion, 2002) were found to be less effective than young adults (college students) in utilizing the option to withhold answers to enhance their accuracy. These results have implications for the dependability of children's testimony in legal settings.

Interestingly, results suggest that the relationship between monitoring and control, what Koriat and Goldsmith (1996b) termed "control sensitivity," may be impaired to some extent in aging (Pansky et al., 2002) and in certain psychotic disorders, such as schizophrenia (Danion, Gokalsing, Robert, Massin-Krauss, & Bacon, 2001; Koren et al., 2004). In the Koren et al. study, for instance, the correlation between confidence judgments in the correctness of a response and the decision to volunteer or withhold that response was highly diagnostic of the degree of insight and awareness that schizophrenic patients showed concerning their mental condition – more so than traditional measures of executive control, such as the Wisconsin Card Sorting Task. Patients exhibiting low control sensitivity were also less able to improve the accuracy of their responses when given the option to choose which answers to volunteer and which to withhold.

The research reviewed above has direct bearing on the question of how people can avoid false memories and overcome the contaminating effects of undesirable influences. Using fuzzy-trace theory as a framework, Brainerd et al. (2003) proposed a mechanism for false-memory editing that allows children and adults to reject false but gist-consistent events. The model also predicts the occurrence of erroneous recollection rejection, in which true events are inappropriately edited out of memory reports.

Payne, Jacoby, and Lambert (2004) investigated the ability of participants to overcome stereotype-based memory distortions when allowed the option of free report. Reliance on subjective confidence allowed participants to enhance their overall memory accuracy, but not to reduce stereotype bias. The results suggested that whereas subjective confidence monitors the accuracy of one's report, stereotypes distort memory

through an unconscious-accessibility bias to which subjective confidence is insensitive. Hence the effects of stereotypes are difficult to control.

The work of Johnson and her associates on source monitoring (see Johnson, 1997; Johnson, Hashtroudi, & Lindsay, 1993) also has important implications for the editing of memory reports. According to the source-monitoring framework, there are several phenomenal cues that can be used by a rememberer to specify the source of a mental record, including such mnemonic cues as vividness, perceptual detail, and spatial and temporal information. Because mental experiences from different sources (e.g., perception versus imagination) differ on average in their phenomenal qualities (e.g., visual clarity), these diagnostic qualities can support source monitoring by using either a heuristically based process or a more strategic, systematic process. Both types of processes require setting criteria for making a judgment, as well as procedures for comparing activated phenomenal information to the criteria.

The broader implication of the work on the strategic regulation of memory accuracy (Koriat & Goldsmith, 1996b) is that, to investigate the complex dynamics between (a) memory (the quality of the information that is available to the rememberer), (b) monitoring, (c) control, and (d) overt accuracy and quantity performance, one must include a situation in which participants are free to decide what to report and what not to report. In fact, in everyday life people have great freedom in reporting an event from memory: They can choose what perspective to adopt, what to emphasize and what to skip, how much detail to provide, and so forth. Such strategic regulation entails complex monitoring and control processes that go beyond the decision to volunteer or withhold specific items of information, and these, too, deserve systematic investigation.

In fact, the conceptual framework of Koriat and Goldsmith was extended to incorporate another means by which people normally regulate the accuracy of what they report: control over the *grain size* (precision or coarseness) of the information that is reported (Goldsmith & Koriat, 1999; Goldsmith, Koriat, & Pansky, 2005; Goldsmith, Koriat, & Weinberg-Eliezer, 2002). For example, when not completely certain about the time of an event, a person may simply report that it occurred "late in the afternoon" rather than "at four-thirty." Neisser (1988) observed that when answering open-ended questions, participants tend to provide answers at a level of generality at which they are not likely to be mistaken. Of course, more coarsely grained answers, although more likely to be correct, are also less informative. Thus, Goldsmith et al. (2002) found that when participants are allowed to control the grain size of their report, they do so in a strategic manner, sacrificing informativeness (degree of precision) for the sake of accuracy when their subjective confidence in the more precise informative answer is low, and taking into account the relative payoffs for accuracy and informativeness in choosing the grain size of their answers. Moreover, 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. A more recent study by Goldsmith et al. (2005), which examined changes in the regulation of grain size over different retention intervals, also yielded results consistent with this model: Starting with the well-known finding that people often remember the gist of an event though they have forgotten its details, Goldsmith et al. (2005) asked whether rememberers might exploit the differential forgetting rates of coarse and precise information to strategically regulate 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 tend to provide coarser answers* at longer retention intervals, in the attempt to maintain a stable level of report accuracy.

In sum, the few studies concerning the control function of metacognition suggest that people rely heavily on their subjective,

metacognitive feelings and judgments in choosing their course of action. In addition to the monitoring output, however, they also take into account a variety of other considerations, such as the goals of learning and remembering, time pressure, emphasis on accuracy versus quantity, and the emphasis on accuracy versus informativeness.

The Effects of Metacognitive Regulation on Memory Performance

Given the dynamics of monitoring and control processes discussed so far, it is of interest to ask, To what extent does the self-regulation of one's processing affect actual memory performance? There are only a few studies that have examined this issue systematically. As noted earlier, under self-paced learning conditions, when participants are free to allocate study time to different items, they tend to divide their time unevenly among the items. Does the self-allocation of study time affect actual memory performance? Nelson and Leonesio (1988) coined the phrase "labor-in-vain effect" to describe the phenomenon that large increases in self-paced study time yielded little or no gain in recall. Specifically, they observed that the amount of self-paced study time increased substantially under conditions that emphasized accuracy in comparison with a condition that emphasized speed. However, the increase in study time resulted in little or no gain in recall.

Metcalfe and her associates (Metcalfe, 2002; Metcalfe & Kornell, 2003) examined systematically the effectiveness of the policy of study time allocation for enhancing memory performance. They found, for example, that learners allocated most time to medium-difficulty items and studied the easiest items first (in contrast to what would be expected from the discrepancy-reduction model, Dunlosky & Hertzog, 1998). When study time was experimentally manipulated, the best performance resulted when most time was given to the medium-difficulty items, suggesting that the strategy that people use under self-paced conditions is largely appropriate. These and other results were seen to accord with the region of proximal learning framework according to which learning proceeds best by attending to concepts and events that are nearest to one's current understanding and only later going on to integrate items that are more difficult.

Thiede, Anderson, and Therriault (2003) used a manipulation that affected the learner's monitoring accuracy in studying text. They found that improved accuracy resulted in a more effective regulation of study and, in turn, in overall better test performance. Thus, learners seem to rely on their metacognitive feelings in regulating their behavior, and to the extent that these feelings are accurate, such self-regulation helps improve memory performance.

With regard to confidence judgments, as noted earlier, the work of Koriat and Goldsmith (1994, 1996b) indicates that when given the option of free report, people enhance their memory accuracy considerably in comparison to forced-report testing and do so by relying on the subjective confidence associated with each item that comes to mind. Because confidence is generally predictive of accuracy, reliance on confidence judgments is effective in enhancing accuracy when accuracy is at stake. However, the effective regulation of memory accuracy comes at the cost of reduced memory quantity, and both the increase in memory accuracy achieved under the free-report option and the reduction in memory quantity depend heavily on monitoring effectiveness.

Koriat and Goldsmith (1996b) evaluated the effectiveness of the participants' control policies given their actual levels of monitoring effectiveness. The participants were found to be quite effective in choosing a control policy that would maximize their joint levels of free-report accuracy and quantity performance, compared to an "optimal" control policy that could be applied directly, based on the confidence judgments assigned to the individual answers under forced report. The effectiveness of the participants' control of grain size in the

Goldsmith et al. (2002) study was much less impressive, however, perhaps because of the greater complexity of the incentive structure (differential payoffs for correct answers at different grain sizes, a fixed penalty for incorrect answers, regardless of grain size). In fact, one of the interesting findings of that study was that participants seemed to adopt a simple "satisficing" heuristic based on the payoff (whether explicit or implicit) and confidence for the more precise-informative answer alone, rather than to compare the expected subjective utility (confidence multiplied by subjective payoff) of potential answers at different grain sizes. Monitoring effectiveness for the correctness of the answers at different grain sizes was, however, also relatively poor (see also Yaniv & Foster, 1997). Thus, it may be that there are limits on the complexity and efficiency of both monitoring and control processes that in turn place limits on the performance benefits that can be achieved through such control.

In sum, only a few studies explored the effectiveness of metacognitive monitoring and control processes in enhancing actual memory performance. More work in this vein is needed.

Metacognition and Consciousness: Some General Issues

In concluding this chapter I would like to comment on how the research on metacognition relates to some of the fundamental issues regarding consciousness and its role in behavior. I discuss three issues: the determinants of subjective experience, the control function of subjective experience, and the cause-and-effect relation between consciousness and behavior.

The Genesis of Subjective Experience

The study of the bases of metacognitive judgments and their accuracy brings to the fore an important process that seems to underlie the shaping of subjective experience. The unique qualities of that process are best highlighted by contrasting experience-based judgment and theory-based judgments. Similar contrasts have been proposed by researchers in both cognitive psychology and social psychology who drew a distinction between two general modes of cognition (see Chaiken & Trope, 1999), and each of these contrasts highlights a particular dimension. Thus, different researchers have conceptualized the distinction in terms of such polarities as Nonanalytic versus Analytic cognition (Jacoby & Brooks, 1984), Associative versus Rule-Based Systems (Sloman, 1996), Experiential versus Rational Systems (Epstein & Pacini, 1999), Impulsive versus Reflective processes (Strack & Deutsch, 2004), Experience-Based versus Information-Based processes (Kelley & Jacoby, 1996a; Koriat & Levy-Sadot, 1999), Heuristic versus Deliberate modes of thought (Kahneman, 2003), and Experiential versus Declarative information (Schwarz, 2004). Stanovich and West (2000) used the somewhat more neutral terms System 1 versus System 2, which have been adopted by Kahneman (2003) in describing his work on judgmental biases.

In this chapter I focused on the contrast between theory-based and experience-based judgments, which seems to capture best the findings in metacognition. As far as metacognitive judgments are concerned, the important assumption is that both experience-based and theory-based judgments are inferential in nature. They differ, however, in two respects. First, theory-based judgments draw upon the content of declarative (semantic and/or episodic) information that is typically stored in long-term memory. Experience-based judgments, in contrast, are assumed to rely on mnemonic cues stemming from the current processing of the task at hand. Such cues as fluency of processing or ease of access pertain to the quality and efficacy of object-level processes as revealed online. Hence, as Koriat (1993) argued, experience-based FOK judgments, for example, monitor the information accessible in short-term memory rather than the information available in long-term memory. It follows that the accuracy of theory-based judgments depends on the validity of the theories and knowledge

on which they are based, whereas the accuracy of experience-based judgments should depend on the diagnosticity of the effective mnemonic cues.

Second, they differ in the nature of the underlying process. Theory-based judgments are assumed to rely on an explicitly inferential process: The process is assumed to be deliberate, analytic, slow, effortful, and largely conscious. In contrast, experience-based judgments involve a two-step process: A fast, unconscious, automatic inference results in a sheer subjective experience, and that subjective experience can then serve as the basis for noetic judgments. Therefore, as Koriat and Levy-Sadot argued (1999), the processes that take off from subjective experience generally have no access to the processes that have produced that experience in the first place.

It is experience-based metacognitive judgments that have attracted the attention of memory researchers who asked the question, How do we know that we know? (e.g., Hart, 1965; Tulving & Madigan, 1970). Experience-based judgments have the quality of immediate, direct impressions, similar to what would follow from the trace-access view of metacognitive judgments. However, as argued earlier, this phenomenal quality could be explained in terms of the idea that experience-based judgments are based on an inferential process that is not available to consciousness, and hence the outcome of that process has the phenomenal quality of a direct, self-evident intuition (see Epstein & Pacini, 1999).

Thus, the work on metacognition nicely converges on the proposals advanced by Jacoby and Kelley (see Kelley & Jacoby, 1993) and by Whittlesea (2002, 2004) on the shaping of subjective experience. These proposals also parallel ideas in the area of social psychology on the genesis of various subjective feelings (see Bless & Forgas, 2000; Strack, 1992). However, although it is theoretically comforting that the distinction between experience-based and theory-based metacognitive processes converges on similar distinctions that have emerged in other domains, a great deal can be gained by attempting to place the metacognitive distinction within a broader framework that encompasses other similar distinctions. For example, research in social psychology suggests that the interplay between declarative and experiential information is greater than has been realized so far (see Schwarz, 2004). However, little is known about the possibility that a similar interplay between the effects of theories and knowledge and those of mnemonic cues occurs also with regard to metacognitive judgments. Also, little research has been carried out that examines the possible effects of attribution and misattribution on metacognitive judgments. Furthermore, processing fluency has been shown to affect a variety of phenomenal experiences, such as liking, truth judgments, recognition decisions, and so on. Again, it is important to examine noetic feelings in the context of these other phenomenal experiences.

The Control Function of Subjective Experience

The issue of metacognitive control emerges most sharply when we ask, What is the status of metacognitive monitoring and control processes within the current distinction between implicit and explicit cognition? In light of the extensive research on both of these areas of research, one would expect the answer to be quite straightforward. However, such is not the case. In an edited volume on *Implicit Memory and Metacognition* (Reder, 1996), the discussions of the participants revealed a basic ambivalence: Kelley and Jacoby (1996b) claimed that "metacognition and implicit memory are so similar as to not be separate topics" (p. 287). Funnell, Metcalfe, and Tsapkini (1996), on the other hand, concluded that "the judgment of what and how much you know about what you know or will know is a classic, almost definitional, explicit task" (p. 172). Finally, Reder and Schunn (1996) stated, "Given that feeling of knowing, like strategy selection, tends to be thought of as the essence of a metacognitive strategy, it is important to defend our claim that this rapid feeling of knowing is

actually an *implicit process* rather than an *explicit process*" (p. 50).

Koriat (1998b, 2000b) argued that this ambivalence actually discloses the two faces of metacognition. He proposed a *crossover model* that assigns metacognition a pivotal role in mediating between unconscious and conscious determinants of information processing. Thus, metacognitive judgments were assumed to lie at the interface between implicit and explicit processes. Generally speaking, a rough distinction can be drawn between two modes of operation: In the explicit-controlled mode, which underlies much of our daily activities, behavior is based on a deliberate and conscious evaluation of the available options and on a deliberate and controlled choice of the most appropriate course of action. In the implicit-automatic mode, in contrast, various factors registered below full consciousness may influence behavior directly and automatically, without the mediation of conscious control (see Bargh, 1997; Wegner, 2002).

Metacognitive experiences are assumed to occupy a unique position in this scheme: They are implicit as far as their antecedents are concerned, but explicit as far as their consequences are concerned. Although a strong feeling of knowing or an unmediated subjective conviction is certainly part and parcel of conscious awareness, they may themselves be the product of an unconscious inference, as reviewed earlier. Once formed, however, such subjective experiences can serve as the basis for the conscious control of information processing and action.

The crossover model may apply to other types of unmediated feelings (Koriat & Levy-Sadot, 1999). Thus, according to this view, sheer subjective feelings, which lie at the heart of consciousness, may themselves be the product of unconscious processes. Such feelings represent an encapsulated summary of a variety of unconscious influences, and it is in this sense that they are informative (see Schwarz & Clore, 1996): They contain information that is relevant to conscious control, unlike the implicit, unconscious processes that have given rise to these feelings. Koriat (2000b) speculated that the function of immediate feelings, such as experience-based metacognitive feelings, is to augment self-control; that is, to allow some degree of personal control over processes that would otherwise influence behavior directly and automatically, outside the person's consciousness and control.

The Cause-and-Effect-Relation between Monitoring and Control

A final metatheoretical issue concerns the assumption underlying much of the work in metacognition (and adopted in the foregoing discussion) – that metacognitive feelings play a causal role in affecting judgments and behavior. However, the work of Jacoby and his associates (see Kelley & Jacoby, 1998) and of Whittlesea (2004) suggests a process that is more consistent with the spirit of the James-Lange view of emotion (see James, 1890): Subjective experience is based on an interpretation and attribution of one's own behavior, so that it *follows* rather than precedes controlled processes. In fact, the assumption that metacognitive feelings monitor the dynamics of information processing implies that such feelings are sometimes based on the feedback from self-initiated object-level processes. For example, the accessibility model of FOK (Koriat, 1993) assumes that FOK judgments are based on the feedback from one's attempt to retrieve a target from memory. Hence they follow, rather than precede, controlled processes. Thus, whereas discussions of the *function* of metacognitive feelings assume that the subjective experience of knowing drives controlled action, discussions of the *bases* of metacognitive feelings imply that such feelings are themselves based on the feedback from controlled action, and thus follow rather than precede behavior.

Recent work that addressed the cause-and-effect relation between metacognitive monitoring and metacognitive control (Koriat, in press; Koriat, Ma'ayan, & Nussinson, 2006; see Koriat, 2000b) suggests that the interplay between them is bidirectional: Although metacognitive monitoring can drive and guide metacognitive

control, it may itself be based on the feedback from controlled operations. Thus, when control effort is *goal driven*, greater effort enhances metacognitive feelings, consistent with the "feelings-affect-behavior" hypothesis. For example, when different incentives are assigned to different items in a study list, learners invest more study time on the high-incentive items and, in parallel, make higher JOLs for these items than for the low-incentive items. This is similar to the idea that we run away because we are frightened, and therefore the faster we run away the safer we feel. In contrast, when control effort is *data driven*, increased effort is correlated with lower metacognitive feelings, consistent with the hypothesis that such feelings are based on the feedback from behavior. For example, under self-paced learning the more effort learners spend studying an item the *lower* is their JOL, and also the lower is their subsequent recall of that item. This is similar to the idea that we are frightened because we are running away, and therefore the faster we run the more fear we should experience. Thus, the study of metacognition can also shed light on the long-standing issue of the cause-and-effect relation between consciousness and behavior.

In sum, some of the current research in metacognition scratches the surface of metatheoretical issues concerning consciousness and its role in behavior and is beginning to attract the attention of philosophers of mind (see Nelson & Rey, 2000).

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