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CHAPTER 13

Consciousness as Meta-Processing

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The invitation to participate in the 25th Carnegie Symposium on Cognition asked participants to consider fundamental issues of consciousness and encouraged us to "let our hair down." We signed up for the task because the company was good and, like many cognitive labs, our lab has always worked on consciousness, whether or not we called it that. That is, we have explored questions about the properties and conditions of certain subjective, mental experiences. For example, what distinguishes simply processing syntax and word meanings from the dramatically different phenomenal experience of comprehending prose (Bransford & Johnson, 1973)? What phenomenal qualities lead people to believe some mental experiences derive from actual, autobiographical events and not from imagination or inference (Johnson & Raye, 1981)? The phenomenal experiences of understanding and remembering certainly are part of what is meant by consciousness.

How might such subjective topics be approached? The most developed example from our lab is our work on the phenomenology and processes involved in source monitoring. This concerns how people attribute particular experiences to sources—for example, how they tell memories for actual events from memories for imagined events, or how they identify Margaret rather than Mieke as the origin of a statement. Source monitoring is central to understanding not only the conscious experience of remembering, but also the conscious experience of believing. Our strategy over the years involves what we have called an *experimental phenomenological approach* (Johnson, 1988b; see also Brewer, 1986). As Flanagan (1992) advocated, we have had faith that understanding subjective experience will accrue from converging evidence from phenomenological (e.g., Johnson, Foley, Suengas, & Raye, 1988), experimental cognitive (e.g., Johnson, Foley, & Leach, 1988; Lindsay & Johnson, 1989), neuropsychological (e.g., Johnson, 1991a), and clinical (Johnson, 1988b) approaches (see Johnson, Hashtroudi, & Lindsay, 1993, for a review). This same strategy can, of course, be applied to many domains (e.g., object perception, neglect, sleep and dreaming), each yielding a view of consciousness within the context of a particular set of problems.

To add to the developing picture, we considered contributing a discussion of our empirical and theoretical work on source monitoring. However, a recent review is available (Johnson et al., 1993) and, in any event, that would hardly have constituted "letting our hair down." More important, it is not clear that a characterization of consciousness in any particular domain will satisfy the impulse to understand Consciousness, with a big *C*, which energizes so much of the thought on this topic. After all, a great deal is known about vision from much elegant research, but it is not generally agreed that vision researchers have solved the problem of Consciousness. What many cognitive psychologists and philosophers seem to want is a way to think about the problem of Consciousness in general terms.

In looking for some unifying principles or concepts, one approach would be to single out a specific *process* or *module* of a cognitive model to identify with consciousness. Along these lines, Klatzky (1984) suggested that information-processing theories have offered three types of candidates for consciousness: an *executive* that controls the flow of information, a *short-term memory* stage of processing, or the state of information being in *focal attention*. A recent variant of the stage or state view (depending on definition) adds consciousness as a module in a subsystems model (e.g., Schacter, 1989). An alternative to identifying consciousness with a particular process or structure is to equate it with a particular type of *content*. According to Kihlstrom (1987), for example, consciousness occurs whenever the concept of "self" is an active element of working memory.

These solutions all seem less than compelling, however. There certainly are states of heightened awareness in which you seem to lose consciousness of yourself; that is part of the attraction of filling your consciousness with intellectual puzzles, novels, scenery, or a beloved. Thus, as important as the "I" of Consciousness is, "I" cannot be the whole story. In addition, it is difficult to see how a single process, structural module, or type of content could give rise to the varieties of consciousness—the differences between, for example, being aware and deciding, or being aware and being aware that one is aware.

A third approach, used here, is to consider *systemwide functional relations* that could give rise to the varieties of consciousness. Our point of departure is the Multiple-Entry, Modular memory system (MEM; Johnson, 1991a, 1991b; Johnson & Hirst, 1993). MEM is a systems-level architecture,[1] designed in a top-down fashion to accommodate a wide range of cognitive phenomena and to incorporate many recurring ideas about processes from the cognitive literature (Johnson, 1983, 1991a, 1991b; Johnson & Hirst, 1991, 1993; Johnson & Multhaup, 1992). This chapter first considers some broad themes that run through many discussions of consciousness and that express what it is that theorists seem to be looking for in treating consciousness as a topic independent of its many domain-specific manifestations. We take these themes to represent what needs to be explained. Then we consider whether or how MEM could accommodate these central themes. We conclude that consciousness arises not from any single component or type of content, but from processing relations among components within a general cognitive architecture that permit certain interactions.

ASPECTS OF CONSCIOUSNESS

Consciousness is notoriously hard to define, but as Churchland (1988) and others noted, theoretical and empirical progress on complicated problems do not depend on starting with firm definitions. Rather than look for a single definition of consciousness, here we have abstracted three general aspects of cognition that commonly appear in discussion of consciousness and that capture much of what psychologists and philosophers seem to have in mind when they consider the concept of consciousness. For short, we have labeled these *awareness, control,* and *representational complexity.*

Awareness

Awareness (as in "to be aware of *X*") is perhaps the most commonly identified aspect of consciousness. For example, Searle (1992) called awareness a near synonym for consciousness (p. 84) and Reber (1985) identified the state of

[1]One way to build a model of a cognitive system is to start with a proposal about data representations and processes, develop simulations for particular tasks, and expand or complicate the model as new features or functions are considered (e.g., the addition of a procedural memory system and representations for temporal strings and spatial images as Anderson's ideas evolved into ACT*; Anderson, 1983). Another way, followed here, is to use available empirical data and theoretical ideas to outline a systems-level architecture or framework that specifies a comprehensive range of cognitive functions, including constraints on them, before investing in any particular simulation strategy (e.g., Moscovitch & Umiltà, 1991; Schacter, 1989; Squire, 1992; Tulving, 1985). Presumably, computational instantiations of such top-down designs eventually would be able to incorporate ideas from computational approaches (e.g., Anderson, 1983; Hintzman, 1986; Holyoak & Thagard, 1989; Metcalfe Eich, 1985; Newell, Rosenbloom, & Laird, 1989; Rumelhart & McClelland, 1986; Simon, 1989; Sejnowski & Rosenberg, 1987).

awareness as the most common usage of "consciousness" in his dictionary of psychological terms (p. 148). Typically, this aspect of consciousness is associated with various kinds of information contents, such as percepts, memories, emotions, and dreams (e.g., Marcel, 1988, p. 123). As we are using it here, then, awareness includes perceptual experiences such as tasting wine, the experience of activities such as swimming, the sense of knowing facts (canaries are yellow), or remembering experiences (the train ride to Bressanone).

Control

Control is that aspect of consciousness that gives us a sense that we can start and stop our own activity. Control is often thought of as a strategic organization of cognitive processes (Umiltà, 1988). And it often entails the notion of monitoring, that is, the idea that outcomes of cognitive operations are compared to criteria, expectations, or goals and that these comparisons influence subsequent processing. Engaging in controlled action and thought gives rise to a sense of efficacy, or intentional, purposeful activity. Umilta (1988, p. 334) suggested that control is the aspect of consciousness "most likely to have a causal role." The notion of control is central to Shallice's (1978) conceptualization of "modular supervisory processes," which organize and augment the activity of other processes, to Johnson-Laird's (1983) idea of consciousness as the "operating system," and to Baddeley's (1992a, 1992b) "central executive."

Representational Complexity

There are several other characteristics of consciousness that we think can be subsumed by the notion that consciousness can range in complexity: that is, it can focus on single mental elements or encompass multiple representations. For example, in addition to awareness and control, an important aspect of consciousness is analytic capability, such as when individuals bring information to bear on making decisions (Johnson & Hirst, 1993). This aspect of consciousness involves seeing alternative points of view and attempts to resolve conflict. Comparing, deciding, evaluating, and seeing another's point of view depend on being able to maintain and negotiate among two or more complex representations (e.g., DeLoache & Burns, 1994). Deliberation is a similar idea that was of particular interest to Popper (Popper & Eccles, 1977), who suggested that consciousness is "where an aim or purpose . . . can be achieved by alternative means, and when two or more means are tried out, after deliberation" (p. 125). Calvin (1989), too, suggested this capacity of organisms to select among multiple actions is the most promising characteristic of conscious experience to examine scientifically.

A special case of complexity arising from multiple representations is the idea that consciousness can be reflective (Jackendoff, 1987), or "self-reflective" (e.g., Stuss, 1991). That is, a concept of self can function as a complex representation in relation to other complex concepts in one's awareness, controlled action, or complex deliberations. Thus, consciousness has been described as occurring when a mental representation of the self is linked with the mental representation of an event (Kihlstrom, 1987) or when an active mental model includes a model of the self (Johnson-Laird, 1988).

We do not, however, want to equate the idea of self only with this latter, complexity, aspect of consciousness. The notion of self might arise from all aspects of consciousness. That is, it is in such activities as tasting wine, engaging in purposeful behavior, and deciding among alternatives that one experiences an "I" or a "self," not only when the self is taken as an explicit object of consciousness.

A Semantic Organization of Mental Concepts

Do these aspects of consciousness identified by psychologists and philosophers reflect the way people understand their own mental experience? This question can be explored by looking at the relations among English words used to refer to mental experience to see if there is converging evidence supporting these three aspects. Of course, studying words is not necessarily equivalent to studying their referents. Yet, one function of words is that they represent any particular culture's efforts to refer to phenomenally salient aspects of experience and, therefore, they are a rich source of evidence and ideas.

A set of 47 words expressing concepts related to *mind* was selected and subjects were asked to make similarity ratings for pairs of words. That is, for each pair of words, subjects were asked to rate the pair for similarity in meaning on a scale that ranged from 0 to 9 where the endpoints were "extremely dissimilar" and "extremely similar." Each subject received a subset of the items, and across 738 Princeton undergraduates, all possible pairs were rated between 32 and 47 times. A multiple dimensional scaling analysis on these similarity ratings was performed, asking for a solution with three dimensions, to see if they converged on the same or different aspects of consciousness as those already discussed. The outcome seems to fit quite well with the critical aspects of consciousness abstracted from the literature.

Figure 13.1 represents two of the three dimensions, with each concept located in two-dimensional space. This plot seems to reflect a dimension of control on the horizontal axis and something that looks like representational complexity on the vertical axis. That is, concepts such as *emotion, impression,* and *dream* are at the low end of control, whereas concepts such as *manipulation, reason,* and *logic* are at the high end. On the vertical axis, concepts such as *sense, attention,* and *awareness* are low in complexity, whereas concepts such as *deliberation, reflection,* and *synthesis,* are at the high end of complexity. That is, mental experiences that can be based on single repre-

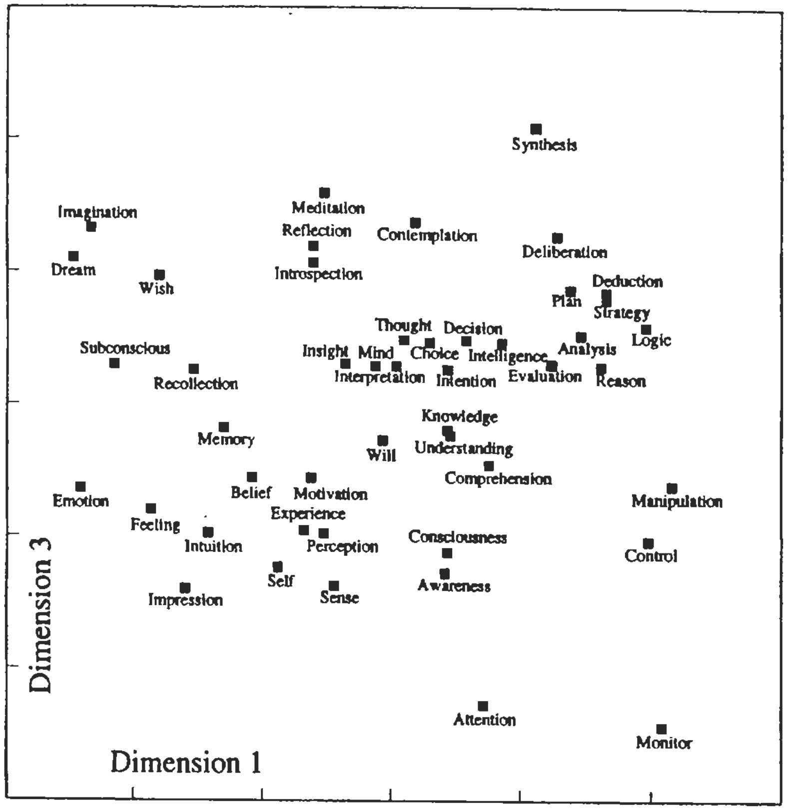

FIG. 13.1. Results of a Multiple Dimensional Scaling analysis of similarity ratings for English words related to *mind*, showing aspects of "control" (horizontal axis) and "representational complexity" (vertical axis).

sentations (a smell, an object, etc.) are lower in complexity than mental experiences that involve multiple representations (comparing, contrasting). Thus, an *emotion* or *impression* is low both in control and complexity, whereas *logic, analysis, deliberation*, and *plan* are high in control and complexity. Notice that the self-reflective activity of *introspection* is high on the complexity scale as well. Overall, this plot nicely points out that control and complexity are not always correlated: Mental activities can be relatively high in control but low in complexity (e.g., simple monitoring or attention) or high in complexity but low in control (e.g., dreams, wishes, some forms of imagination).

Figure 13.2 again has the complexity dimension on the vertical axis, and now a dimension on the horizontal axis that appears to match what we are calling the aspect of awareness. As discussed earlier, the aspect of consciousness here called *awareness* is strongly associated with conscious *contents* (e.g., percepts and memories). Baars (1988) further delineated the concept of conscious contents by distinguishing it from the concept of goal contexts. The horizontal dimension in Fig. 13.2 is consistent with this distinction. Words to the left (e.g., *motivation, wish, intention, plan*) are associated with motivation and potential action; words to the right (e.g., *recollection, knowledge, perception, deduction*) refer to conscious contents or to cognitive operations that primarily produce contents.

Although other dimension names or alternative approaches to analyzing the relations among mental terms are certainly possible (see, e.g., D'Andrade,

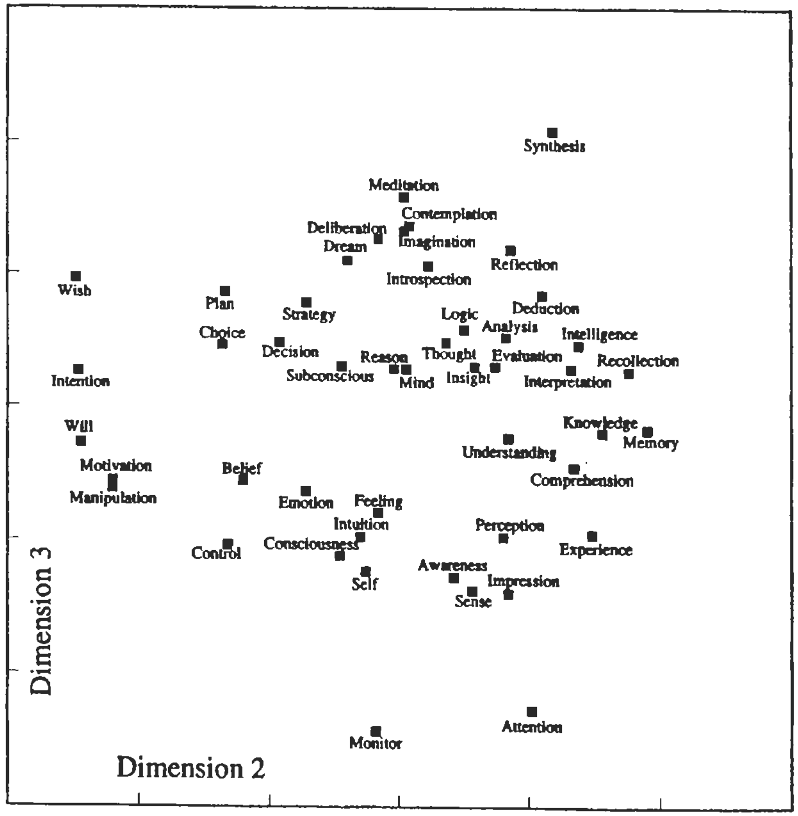

FIG. 13.2. Results of a Multiple Dimensional Scaling analysis of similarity ratings for English words related to *mind*, showing aspects of "awareness" (horizontal axis) and "representational complexity" (vertical axis).

1987; Rips & Conrad, 1989), on the whole, the Multiple Dimensional Scaling analysis depicted in Figs. 13.1 and 13.2 is consistent with the central ideas derived from the literature. Major aspects of consciousness include awareness, control, and a complexity factor that reflects the extent to which multiple representations contribute to phenomenal experience. It should not be surprising that everyday language and scholarly inquiry would converge on common themes when the topic is phenomenal experience.

A GENERAL COGNITIVE ARCHITECTURE: MEM

If awareness, control, and representational complexity are accepted as distinct aspects of consciousness, then what are the various cognitive processes and interactions that produce these phenomenal qualities of consciousness? This chapter proposes that these aspects of consciousness can be viewed as a derived product of the right system-level cognitive architecture. There is some set of cognitive architectures that could do this. This chapter suggests that these various aspects of consciousness can be characterized within a particular cognitive architecture—the MEM system proposed by Johnson and colleagues (Johnson, 1983, 1990, 1992; Johnson & Chalfonte, 1994; Johnson & Hirst, 1991, 1993; Johnson & Multhaup, 1992).

The MEM Framework

The MEM framework is a process-oriented approach to describing memory in particular and cognition in general. The ideas embodied in MEM are derived from a wide range of empirical findings, theoretical proposals, and recurring insights about cognition—for example, that there are processes for locating and identifying objects (e.g., Biederman, 1987; Mishkin, 1982; Rock & Gutman, 1981); organizing, elaborating, and finding relations (e.g., Gentner, 1988; Mandler, 1967; Tulving, 1962); maintaining activation (e.g., Atkinson & Shiffrin, 1968; Baddeley, 1986); retrieving information (e.g., Reiser, 1986); and guiding thought and action (e.g., Bartlett, 1932; Miller, Galanter, & Pribram, 1960; Shallice, 1988). The particular structural arrangement of processes in MEM is consistent with major phenomena of current interest, such as dissociations among memory measures (e.g., Jacoby & Dallas, 1981), patterns of breakdown in cognition from brain damage (e.g., Cohen & Squire, 1980; Stuss & Benson, 1986), and differences in the controllability of processes (e.g., Hasher & Zacks, 1979; Norman & Shallice, 1986; Posner & Snyder, 1975); and with central ideas about the relation between cognition and emotion (e.g., Lazarus, 1982; Mandler, 1984; Roseman, 1984; Smith & Ellsworth, 1985), and about the development (e.g., Flavell & Wellman, 1977; Kail, 1984;

Schacter & Moscovitch, 1984) and evolution (e.g., Ekman, 1984; Reber, 1989) of cognition.

We begin with an overview of MEM and related evidence (see also Johnson, 1983, 1990, 1991a, 1991b, 1992; Johnson & Chalfonte, 1994; Johnson & Hirst, 1991, 1993; Johnson & Multhaup, 1992). Next we show how MEM could give rise to the three major aspects of consciousness described previously, and then we consider how disruptions in consciousness might come about within the MEM framework.

The lower level elements of the MEM framework are component processes. In MEM, a component process constitutes a particular manipulation of information. The current version of MEM includes 16 such component processes that operate on information in qualitatively different ways (Fig. 13.3). The performance of any mental task involves some combination of these component processes, and memory is viewed as a record of the operation of the component processes. Furthermore, MEM includes an organizational framework that groups component processes according to broad functional classes or subsystems. In the nomenclature of MEM, the P-1 and P-2 subsystems include relatively simple and more complex *perceptual* processes, respectively, whereas the R-1 and R-2 subsystems include simple and complex *reflective* processes. The organizational class, or subsystem, to which a component process belongs reflects our speculations about the type of information it preferentially acts on, other component processes with which it frequently operates, its degree of computational sophistication or elaborateness, the evolutionary stage at which it might first have arisen, and the brain mechanisms by which it might be mediated. Furthermore, the concept of separate but interacting subsystems is critical for addressing consciousness and the "homunculus."

As shown in Fig. 13.3c, the component processes of P-1 are *locating* stimuli, *resolving* stimulus configurations, *tracking* stimuli, and *extracting* invariants from perceptual arrays. P-1 processes are involved in learning and memory, but we usually are not directly aware of the perceptual information that is operating as cues. P-1 processes underlie such skills as adjusting to a person's foreign accent or anticipating the trajectory of a baseball.

The component processes of P-2 are *placing* objects in spatial relation to each other, *identifying* objects, *examining* or perceptually investigating stimuli, and *structuring* or abstracting a pattern of organization across temporally extended stimuli. P-2 processes are responsible for much of our phenomenal experience of the external world. They provide us with a subjective world of objects and events, organized meaningfully based on prior experience. Relative to P-1, the processes of P-2 can operate on more complex data structures. For example, *locating* (a P-1 process) can be applied to an undifferentiated external stimulus, whereas *placing* (a P-2 process) computes relative positions of two differentiated and usually identified objects.

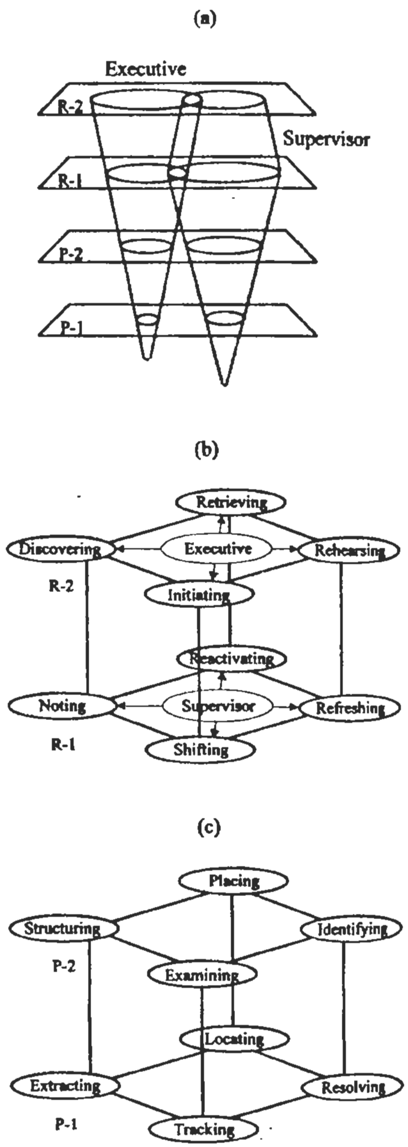

FIG. 13.3. The Multiple-Entry Modular (MEM) memory system: (a) The reflective and perceptual subsystems (R-1 and R-2, P-1 and P-2, respectively) interact with each other through the executive and supervisory functions of agendas; (b) component processes of the reflective subsystems, R-1 and R-2; (c) component processes of the perceptual subsystems, P-1 and P-2.

The component processes of the two reflective subsystems, R-1 and R-2, allow us to go beyond the perceptual world (Fig. 13.3b). They permit the manipulation of self-generated and externally derived information and memories and allow us to anticipate future events, imagine possible alternatives, and so forth. Both R-1 and R-2 involve component processes that allow people to sustain, organize, and revive information. R-1 and R-2 differ in the complexity of tasks they can handle. For example, R-1 processes would be sufficient for coming up with the idea of having a party, but R-2 processes would be necessary for planning one. In R-1 the component processes are *refreshing* information so that it remains active and one can easily shift back to it, *shifting* attention to something potentially more useful, *noting* relations, and *reactivating* information that has dropped out of consciousness. Component processes in R-2 include *rehearsing, initiating, discovering*, and *retrieving*. Relative to R-1, R-2 processes typically deal with more complex data structures. For example, *noting* (R-1) can compute overlapping relations from associations activated by two items (e.g., *dog* and *cat* both activate *animal*). In contrast, *discovering* (R-2) finds relations that are less direct, for example, relations that depend on other relations as in computing analogies (e.g., Gentner, 1988).

The component processes derive great functional power from the fact that they can be marshaled and executed by agendas. Agendas recruit processes in the service of goals—a combination of goals and component processes constitutes what we call an *agenda*. An agenda can be thought of as a script or recipe. That is, a recipe is somewhat more flexible than a program; its instantiation allows for some opportunistic flexibility and improvisation. Most agendas are learned through experience.

Agendas coordinate *control* and *monitoring*. Control is, in effect, the execution of the operations as specified in the agenda. Monitoring is accomplished by matching consequences of executed processes against expectations embodied in or activated by the agenda. In Fig. 13.3, the *Supervisor* and *Executive* are ways of referring, collectively, to potential R-1 and R-2 agendas, respectively. Thus, there is no unitary executive mechanism in either subsystem; the operation of an agenda creates a "virtual" executive (cf. Dennett's, 1991, virtual "captain").

One way the subsystems of MEM interact with one another is through activated agendas (see Fig. 13.3a). For example, an agenda initiated in R-2 such as *look for a restaurant*, might activate relevant perceptual schemas from perceptual memory (e.g., look for a building with ground-level window, tables visible, menu in window).[2] The agenda might also activate reflective plans adapted to the current situation (e.g., check the restaurant guide for this part of town). Typically, agendas have greater access to reflective memory records

[2]Like the reflective agendas of R-1 and R-2, perceptual schemas are ways of representing learned coordination among component processes within P-1 and P-2.

than to perceptual memory records, and greater access to P-2 than to P-1 records (as suggested by the sizes of the ellipses at the intersects of cones and planes in Fig. 13.3a). This greater access could reflect a higher level of change in activation, a faster speed of access, access to a larger domain of representations, or some combination of these.

An especially important aspect of reflection is that the supervisor and executive agendas in R-1 and R-2 can recruit (control and monitor) each other, as depicted by their overlap. Interaction between R-1 processes and those in R-2 greatly increases the complexity of tasks that can be handled (e.g., interaction between R-1 and R-2 provides one mechanism for sequencing subgoals). More central to the issues addressed by this symposium, interaction between R-1 and R-2 is the basis for phenomenal experiences such as reflecting on reflection (i.e., introspection) and self-control, which are among the most complex forms of consciousness that we experience. More generally, consciousness is associated with interactions across subsystems, as discussed later.

MEM proposes a midlevel vocabulary for the minimum number of component processes—and their schematic, architectural arrangement—necessary to characterize a fully functioning adult cognitive system. This, of course, is only one "grain-size" for analysis and understanding. Each component process in MEM could be broken down further—for example, abstracting "geons" (Biederman, 1987) might be a subcomponent of *identifying*, or the component process of *noting* could be decomposed into types of relations (e.g., parts, category membership) or activities (comparing, contrasting). At the same time, MEM's component processes (e.g., *refreshing, shifting, noting, reactivating*) could be used to decompose more general-level concepts in the literature, such as "organizing" or "elaborating" (e.g., Johnson & Hirst, 1993).

At the intermediate level of description, we intend for MEM to be exhaustive—that is, our goal is to represent a full set of processes required for a cognitive architecture described at this level of analysis. For example, locating in vision and locating in audition are clearly not the same, but *locating* is a fundamental operation in both modalities. Or, to take another example, we do not include "inferencing" as a specific component process in MEM but rather assume inferencing takes place in all subsystems. *Extracting* invariants or *structuring* patterns can be viewed as types of perceptual inference processes. More complex inferencing derives from the joint activity of component reflective processes. For example, *noting* the relation of an activated semantic associate to presented text might lead to the conclusion that an unmentioned hammer was probably used to pound a nail; in playing the board game "Clue," *initiating* a systematic move through the rooms in combination with *retrieving* the outcomes of previous plays might lead to *discovering* that the murderer was Miss Scarlet in the kitchen with the knife. If attempts to use MEM to characterize new domains lead to the discovery that the current component processes are not sufficient, there would be a rationale for replacing those that have been postulated with more general processes or for adding new ones. Although MEM is a working hypothesis and not a final proposal, it entails the idea that there is a relatively limited set of processes that constitute a useful conceptual analysis of memory at this intermediate level.

Alternatively, it may seem that there are not too few components in MEM, but rather there are too many. That is, perhaps MEM's higher order processes could be decomposed into MEM's lower order processes. MEM's architecture is not, however, nested in this fashion. For example, we would not expect to find that an R-1 component process could be fully decomposed into P-2 component processes or that a P-2 component process could be decomposed into P-1 component processes. Rather, decomposing MEM's component processes requires a more specific level of analysis that is not represented in MEM. For example, *shifting* may subsume a "disengage" process (Posner, Petersen, Fox, & Raichle, 1988) that is not represented at MEM's level of analysis.

Although not nested, there are relations between component processes across MEM's subsystems. We have speculated that higher level processes along the vertical columns (see Figs. 13.3b and 13.3c) in MEM might have evolved out of earlier component processes in the same column (Johnson & Hirst, 1993). Nevertheless, the critical idea here is "evolved." Higher order processes might draw on the outcomes of lower ones without being decomposable into these same lower processes. Evolution implies that something has been added. For example, *placing* involves not simply a string of *locating* computations, but rather the capacity to simultaneously represent two or more items within a common frame.

Empirical Evidence

As with any framework, the level of analysis was determined in part by the types of empirical findings we were attempting to account for. In the initial generation of MEM (Johnson, 1983), a distinction between perceptual and reflective records was offered as a solution to, among other problems, the apparent paradox that memory seems both accurate and inaccurate. The MEM model proposed that veridical memory is obtained when a test taps into representations created by perceptual processes designed to detect highly probable recurrences and invariants (Brunswik, 1956; Gibson, 1966) and to record perceptual features, accounting for such findings as modality-specific effects (Craik & Kirsner, 1974; Hintzman & Summers, 1973) and contributing to verbatim memory (Kintsch & Bates, 1977). In contrast, memory distortions arise when tests tap into representations created by reflective processes engaged when people anticipate, draw inferences, reminisce, plan, and otherwise manipulate ideas. Because reflective activity leaves a record, people sometimes mistake their embellishments of information for fact (e.g., Johnson, Bransford, & Solomon, 1973). In addition, evidence for a distinction between perceptually derived and reflectively generated representations includes subjects' frequent success in discriminating between these types of representations and differential effects of variables on memory for perceptually derived and reflectively generated events (Johnson & Raye, 1981).

The distinction between P-1 and P-2[3] was postulated to account for phenomena such as the effects of prior exposure, especially modality-specific effects and subthreshold effects, which do not necessarily produce phenomenal experience (e.g., Fowler, Wolford, Slade, & Tassinary, 1981; Jacoby & Dallas, 1981; Kunst-Wilson & Zajonc, 1980; D. Scarborough, Cortese, & H. Scarborough, 1977), the cumulation of information over trials each alone too brief to permit stimulus identification (Haber & Hershenson, 1965), memory for some aspects of unattended information (Rock & Gutman, 1981), and more exotic findings such as long-term retention of random dot patterns that had not yet been synthesized into phenomenal objects (Stromeyer & Psotka, 1970) and blindsight (Weiskrantz, Warrington, & Sanders, 1974). Such findings seemed to point to a division between perceptual processing that leaves a record that can be used in subsequent perceptual processing and that plays a critical role in perceptual motor tasks and skill learning (P-1), and perceptual processing that results in phenomenally recoverable memories of objects and events (P-2). In contrast, the reflection system was assumed to provide the major mechanisms underlying the creative combination and voluntary recovery of information such as illustrated by organizational activities in free recall (e.g., Mandler, 1967; Tulving, 1968).

In short, although most tasks are unlikely to tap into one subsystem only, dissociations among memory measures are nevertheless likely because different measures draw disproportionately on different memory subsystems; for example, recall draws relatively more on reflective records, recognition on P-2 records, and priming or perceptual identification tasks on P-1 records. This basic framework, although primarily generated by considering findings from normal adult cognition, was also applied to findings reported from studies of amnesia drawing on reviews by Hirst (1982), Moscovitch (1982), and Baddeley (1982), as well as a number of other theoretical proposals (e.g., Cermak, 1977; Huppert & Piercy, 1982; Warrington & Weiskrantz, 1970; Wickelgren, 1979). Using the MEM framework, it was proposed that the pattern of amnesic deficits—profound deficits in recall along with relatively preserved perceptual and motor skill performance (e.g., rotary pursuit, reading mirror images of words, identifying the objects in degraded pictures)—could be accounted for by postulating the anterograde amnesia results from a deficit in

[3]P-1 and P-2 processes were initially called "sensory" and "perceptual," respectively (Johnson, 1983).

the reflective subsystem with the perceptual subsystems relatively intact. Thus, it would be expected that amnesics show preserved performance in tasks largely served by the P-1 and P-2 subsystems and increasing deficits as tasks require greater amounts of reflection at encoding or at test.

The distinction between R-1 and R-2 was introduced later to capture something of the processing complexity and nuance ignored by more global ideas such as reflection, effort, attention, capacity, and control (Johnson, 1990, 1991a, 1991b; Johnson & Hirst, 1991). First, global categories such as "reflection" or single dimensions such as "control" do not explicate foundational concepts such as chunking (Miller, 1956; see Johnson, 1990). Furthermore, executing two layers of organization (e.g., categorizing and alphabetizing within categories) requires the ability to negotiate two agendas. Once two interactive reflective subsystems are postulated that each have mechanisms for maintaining, reviving, and organizing information, it becomes relatively easy to incorporate the fact that disruption of reflective processes, like disruption of perceptual processes, can be quite selective. For example, memory disorders come in a number of varieties and degrees of severity (e.g., Johnson & Hirst, 1991). Some patients appear to show selective disruption of *refreshing* and/or *rehearsing* ("short-term memory" deficits, Vallar & Baddeley, 1984; Warrington, 1982). Others appear to show selective disruption of *reactivating*, a reflective activity that is critical for binding features and consolidating them into complex memories (anterograde amnesia, Johnson & Chalfonte, 1994; Squire, 1987). Still others appear to show selective disruption of those aspects of remembering that depend on processes such as *shifting*, *noting*, and *retrieving* that are critical for organizing and self-cuing ("frontal" or "executive" deficits, Baddeley, 1982). A more complex view of the relation between reflection and memory should help integrate findings implicating many brain areas in memory disorders: for example, temporal and diencephalic lesions may have a relatively larger impact on R-1 processes and frontal lesions a relatively larger impact on R-2 processes (Johnson, 1990).

The distinction between R-1 and R-2 also accommodates proposed differences in judgment processes that have been useful for analyzing a variety of tasks, including old/new recognition and source monitoring. Johnson and Raye (1981), for example, made a distinction between reality monitoring judgments based, on the one hand, on relatively quick assessment of activated trace characteristics (e.g., amount of perceptual detail) and, on the other hand, judgments based on additional retrieval and more extended reasoning (e.g., is this plausible given other things I know?). Within the MEM framework, the former result from R-1 processes and the latter from R-2 processes. This distinction is similar to Chaiken, Lieberman, and Eagly's (1989) distinction between heuristic and systematic processing, and encompasses the idea that heuristic judgments might be based on familiarity whereas systematic judgments involve more active recall processes (e.g., Gardiner & Java, 1990; Jacoby & Dallas, 1981; Mandler, 1980).

In addition, patterns of confabulation in brain-damaged patients are consistent with the idea that R-1 and R-2 can be selectively disrupted (Johnson, 1991a). For example, the confabulations of some patients are realistic and may include confusions among elements of actual autobiographical events, whereas the confabulations of other patients are bizarre or fantastic. Relatively realistic confabulation could result from deficits in R-1 processes, for example, overly lax criteria for source monitoring in which ideas that come to mind are treated as reflecting true episodic memories based on familiarity or minimal amounts of perceptual and contextual detail (see also Moscovitch, 1989). Lax criteria could result if such processes as *shifting* to more appropriate criteria or *noting* other trace characteristics are impaired (as well as, of course, from reduced motivation to engage in reality monitoring). In contrast, more bizarre confabulations appear to be produced by disruptions of R-2 processes, for example, deficits in *retrieving* additional semantic and episodic information that could be used for *discovering* inconsistencies or implausible aspects of what is remembered.

Generally speaking, we have been encouraged by the continuing accumulation of evidence that is consistent with the MEM framework (although many studies were motivated, of course, by other conceptions of cognition and memory). Dissociations among memory measures are now among the central, to-be-explained facts of the field (e.g., Richardson-Klavehn & Bjork, 1988). There are numerous demonstrations that indirect measures of memory that do not depend on phenomenally available event records (e.g., perceptual identification, pattern drawing) show savings and such savings can be independent of performance on direct measures such as recognition or recall (e.g., Musen & Treisman, 1990). Even "unattended" information has persisting effects, supporting the idea that P-1 processing alone is sufficient to create memory records (Eich, 1984; DeSchepper & Treisman, 1996), but not sufficient to produce the P-2 records required for, say, frequency judgments about complex events defined by the conjunctions of features (Johnson, Peterson, Chua-Yap, & Rose, 1989).

The proposition that amnesics have relatively intact P-1 and P-2 subsystems and thus should have intact performance on perceptually based tasks also has received considerable support. Amnesics show savings in processing random dot stereograms (Benzing & Squire, 1989) and priming in a variety of other perceptually based tasks (e.g., Musen & Squire, 1992; Schacter, Cooper, Tharan, & Rubens, 1991). Amnesics show preserved effects of frequency of exposure on recognition (Johnson, Kim, & Risse, 1985; Johnson & Multhaup, 1992), preserved recognition when reflective processing is minimized by task demands (Weinstein, 1987; also cited in Johnson, 1990), or when the reflective component of recognition is subtracted out (Verfaellie &

Treadwell, 1993; see Jacoby, 1991), and relatively preserved recognition in relation to recall (Hirst, Johnson, Kim, Phelps, Risse, & Volpe, 1986; Hirst, Johnson, Phelps, & Volpe, 1988; but see Haist, Shimamura, & Squire, 1992). Amnesics also show deficits in acquisition of affect (Johnson et al., 1985) and in skill learning (Phelps, 1989) that appear to be related to the degree of reflection required by the task.

A by-product of the intense interest generated by memory researchers' rediscovery of indirect or savings measures of memory is that exploration of reflective processes has lagged somewhat. However, the idea that a full account of memory must include a specification of the role of complex reflective processing involved in encoding and retrieval is beginning to have its own revival, as evidenced by the increasing interest in controlled (i.e., reflective) processes in skill acquisition (Seger, 1994), and in the role of frontal functions in memory (e.g., Craik, L. W. Morris, R. G. Morris, & Loewen, 1990; Kopelman, 1989; Moscovitch & Umiltà, 1991; Shimamura, Janowsky, & Squire, 1990; Tulving, Kapur, Craik, Moscovitch, & Houle, 1994; see also Johnson et al., 1993).

Along with accumulating empirical evidence, there is also an encouraging convergence of theoretical ideas consistent with some of MEM's fundamental assumptions, for example, that memory is a record of processing (Kolers & Roediger, 1984); that characterizing this processing in terms of component processes is a central goal for cognitive-level theories (e.g., Moscovitch, 1992); that processing and subsystems accounts are not necessarily incompatible (e.g., Schacter, 1990); that there are subsystems that represent perceptual information (Musen & Treisman, 1990; Tulving & Schacter, 1990); that some memory records can mediate responses in the absence of awareness (Kihlstrom, Barnhardt, & Tataryn, 1992); and that memory subsystems reflect an evolutionary history in which veridical representations of perceptual stimuli appeared earlier than embellished, reflectively generated representations (Reber, 1989). Finally, there appears to be increasing recognition that interactions among subsystems are as important as dissociations. For example, perceptual subsystems are especially important in mediating certain types of perceptual-motor action but perceptual and reflective processes interact in skill learning (Seger, 1994).

Characterizing the relations among empirical findings and common theoretical themes remains a central goal of our efforts. We believe that a midlevel conceptual schema such as MEM is desirable for a sense of the "whole" of cognition. With fewer analytic units, the full, flexible range of cognition is difficult to depict and to see, and with too many more, the cohesive, integrated nature of cognition is lost in detail. As is discussed in the next section, such a midlevel conceptual schema is especially appropriate for explicating Consciousness with a big "C."

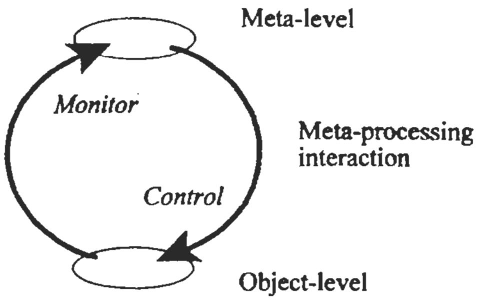

FIG. 13.4. Meta-processing: the monitoring and controlling of an object level by a meta-level.

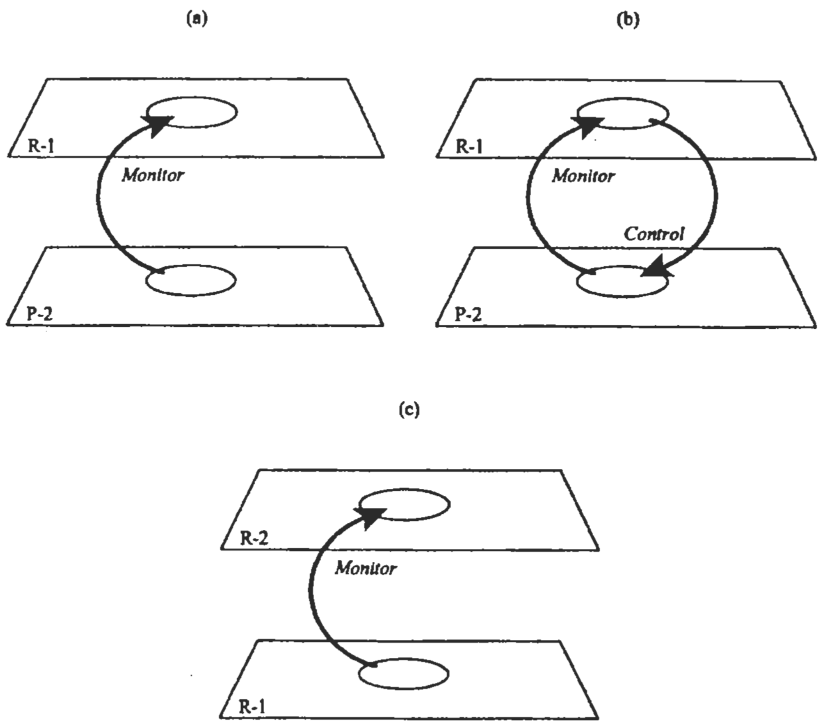

FIG. 13.5. Meta-processing interactions between two MEM subsystems: (a) awareness or "looking at" characterized as R-1 monitoring P-2; (b) control or "looking for" characterized as R-1 monitoring and controlling P-2; (c) awareness of thinking characterized as R-2 monitoring R-1.

CONSCIOUSNESS AND MEM

Consider the proposition that in MEM consciousness occurs when an active agenda recruits component processes across subsystems. In order to help characterize these across-subsystem transactions that we propose underlie consciousness, a useful distinction is one made by Nelson and Narens (1990) between meta-level and object-level processing (Fig. 13.4). According to Nelson and Narens, two processing relations or transactions can hold between these levels: monitoring and control (cf. Kihlstrom, 1984, p. 150). In *monitoring*, the meta-level's model of the situation is changed as it observes the object level. Whereas the object level is not affected by being monitored, through *control*, the meta-level causes processes in the object level to be activated, continued, or terminated. (Although it seems unlikely that any process or representation can be "examined" without affecting it in some way, this point is not critical for the present discussion.) In MEM, any subsystem can be an "object level"; here the focus is on the meta-level roles of R-1 and R-2. As different subsystems play the meta- and the object-level role in different situations, different types of conscious experience result.

Examples of Meta-processing Across Subsystems

As an example of this "meta-processing," take the case where P-2 is the object level for an R-1 agenda; if R-1 is only monitoring P-2, you would have a type of conscious experience we call *awareness*, say, the experience of watching or "looking at" fish in an afternoon of relaxed snorkeling (Fig. 13.5a).[4] If R-1 is also controlling P-2, you might have the sense of "looking for" a particular object (e.g., a sea urchin; Fig. 13.5b). In this case, a perceptual schema in P-2 for what urchins look like may be activated as a result of an R-1 agenda that is executed for checking the parts of a reef where you know it is more likely that you will find sea urchins. Consider another example where R-1 is the object level for R-2 (Fig. 13.5c). If only monitoring is taking place, you would have an awareness of observing your thoughts (e.g., a sense of being aware that you are thinking that there may be sea urchins at the reef). Or, if R-2 is monitoring while R-1 is monitoring and controlling P-2 (Fig. 13.6a), you would have a sense of observing yourself trying to do something (e.g., being aware of yourself trying to find a sea urchin). If R-2 were also controlling R-1, you might have the experience of planning (e.g., you might tell yourself to look first at

[4]These hypothetical situations illustrate varieties of phenomenal experience such as the difference between looking for something and being aware that you are looking for something. The section "Disruptions of Consciousness," goes beyond this appeal to everyday experience and suggests that a MEM-based account of consciousness can be applied to the types of empirical evidence yielded by studies of brain-damaged patients.

the near reef and, if no urchins are found, venture out to the far reef) (Fig. 13.6b).

More complex conscious experiences arise when a subsystem monitors and controls two or more object-level representations simultaneously. These object-level representations might be from different subsystems or from a single subsystem. For example, R-1 might monitor representations from P-2 and R-2; here you might be aware that you are both watching a sea urchin and try-

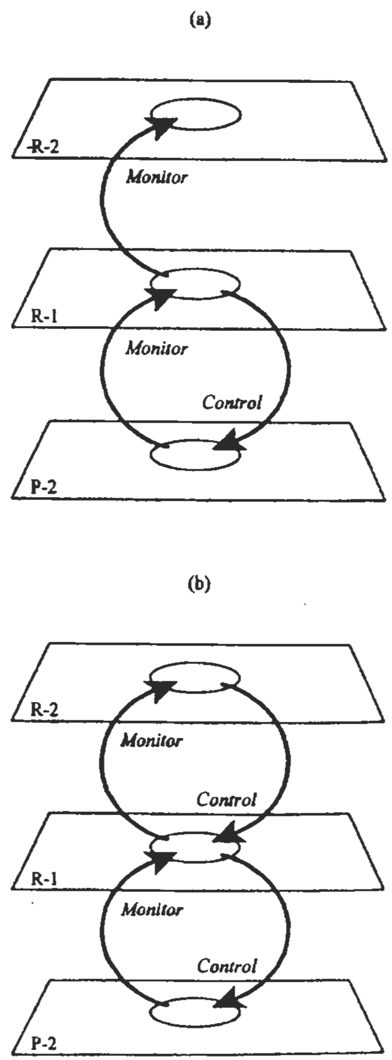

FIG. 13.6. Recursive meta-processing interactions among three MEM subsystems: (a) self-observation of purposeful activity characterized as R-2 monitoring R-1 as R-1 monitors and controls P-2; (b) self-regulation of purposeful activity (e.g., planning) characterized as R-2 monitoring and controlling R-1 as R-1 monitors and controls P-2.

ing to retrieve whatever information you have been told about them (e.g., retrieve names of people who might have an interest in snorkeling in order to remember what they might have told you) (Fig. 13.7a). If R-2 were monitoring and controlling which R-1 agenda is followed (look for urchins or look for flounder), you might have the experience of deciding (Fig. 13.7b). If you were deliberating between R-1 agendas, such as finding sea urchins and going back

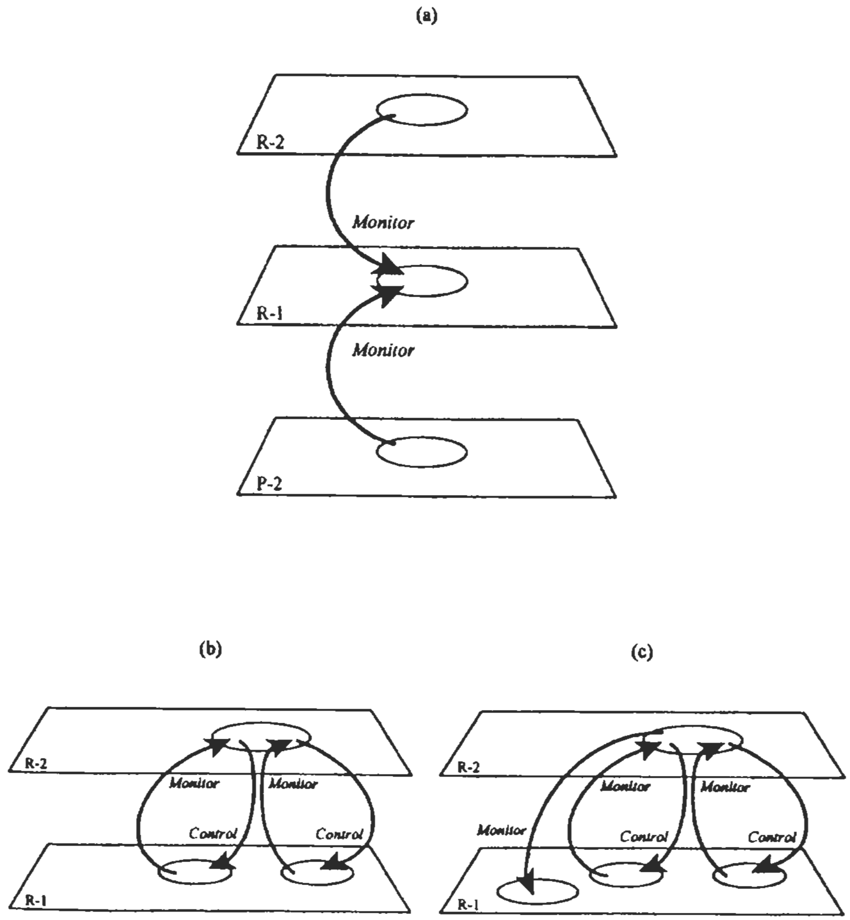

FIG. 13.7. Representationally complex meta-processing interactions between MEM subsystems: (a) simultaneous perceptual (e.g., looking at) and reflective (e.g., retrieving related information) awareness characterized as R-1 monitoring both P-2 and R-2; (b) deciding characterized as R-2 monitoring and controlling two R-1 representations (e.g., agendas); (c) self-control characterized recursively as R-1 monitoring R-2 as R-2 monitors and controls two R-1 representations (e.g., agendas).

to your hotel room to write a paper, you might experience self-control. (Notice that the difference between deciding and self-control is often in the nature of the representations and values attached to them.) Complex consciousness is sometimes recursive; for example, if R-1 were monitoring your decision (executed by R-2 processes) to continue looking for urchins or write a paper, you might be aware you are exercising self-control (Fig. 13.7c).

Awareness, Control, and Representational Complexity in MEM

As illustrated by the previous examples, interactions between subsystems can take various forms. At the most general level, these forms correspond to the three fundamental aspects of consciousness outlined in an earlier section: awareness, control, and representational complexity. In MEM, awareness derives from meta-processing that consists largely of monitoring the outcomes of component processes. Control derives from meta-processing in which agendas recruit component processes and engage in corresponding error correction processes as outcomes are matched to agendas. Representational complexity derives from monitoring and control of processes applied to two or more representations, as in noting conflicts among representations or discovering compromise representations.[5] Thus, within MEM, such differences in conscious experiences as *looking at* (monitoring), *looking for* (control), and *comparing* (representational complexity) are relatively straightforward.

It is also possible to characterize differences within a particular aspect of consciousness. For example, within the domain of awareness, one can be *looking at* (aware of) either external events (e.g., R-1 monitoring P-2) or internal events (e.g., R-2 monitoring R-1). That is, one's awareness can be directed outward toward the perceptual environment or inward toward one's thoughts. Within the domain of control, one can be *looking for* an external object (e.g., R-1 controlling P-2) or for an idea or memory (e.g., R-1 controlling R-2). Within the domain of representational complexity, *comparing* can involve representational complexity when two or more perceptually derived representations are compared (e.g., similarity judgments between pictures), when two or more reflectively generated representations are compared (e.g., similarity judgments between abstract concepts such as awareness and control), or when perceptually derived and reflectively generated representations are compared (e.g., similarity judgments between an actress and the idea of the character one has imagined based on reading the play). In short, with relatively few assumptions, the MEM architecture can yield the diverse subjective experiences implicit in what we mean by consciousness.

[5] Although the focus here is on complexity introduced by multiple representations, even for individual representations, complexity may increase from P-1 to R-2 in that reflective representations and level 2 (P-2 and R-2) representations tend to encompass and integrate more elements than perceptual and level 1 (P-1 and R-1) representations, respectively.

Consciousness and Attention

In MEM consciousness and attention are distinguished. As discussed elsewhere (Johnson & Hirst, 1993), "attention" is engaging component processes such as *locating*, *noting*, and so forth. There is no separate, single attentional mechanism (see also Allport, 1993). Component processes engaged by well-learned agendas within a subsystem would not necessarily give rise to a conscious experience (e.g., to take a familiar example, sometimes in driving to work, driving involves "attention" but is not necessarily conscious). Thus, consciousness can be distinguished from attention in that consciousness includes the idea that processes are engaged and monitored by another subsystem, whereas attention does not necessarily involved transactions across subsystems.

Evolution and Development of Consciousness

The evolution and development of consciousness can be represented in MEM as well. Assume that the cognitive system evolved in the order P-1, P-2, R-1, and R-2 and that development from infancy to adulthood proceeds in the same order. This means the conscious experiences of an organism functioning with, say, P-1 and P-2 only would be quite different from the conscious experiences of an organism functioning with R-1, which in turn would be different from the experiences of one functioning with R-2 as well. Note that in MEM, consciousness does not depend on a single mechanism—such as a single, centralized executive system or language. Rather, consciousness depends on the capacity for transactions between subsystems that have a certain architectural arrangement. Therefore, prelinguistic humans and other animals are presumed to have conscious experiences. Insofar as language helps us represent and manipulate multiple complex concepts, it increases the range of possible conscious experiences.

The Function of Consciousness

As we are using it here, *consciousness* is a summary term for the various phenomenal experiences arising from cognitive activities. Nevertheless, this does not mean that consciousness is "epiphenomenal." Because consciousness has phenomenal properties, it can serve the causal, *motivational* functions of phenomenal experiences—we act in order to bring into being, or to maintain, or to escape certain conscious experiences. For example, someone who is cooking engages in a rich mixture of thoughts and actions in creating a crème brulée in order to bring about a particular state of conscious experience later. In fact, much of what we do (drinking wine, going to the movies, snorkeling, concocting theories) is done to manipulate the aspects of consciousness we call awareness, control, and cognitive complexity.

Disruptions of Consciousness

The fact that different subsystems mediate different aspects of perception and reflection underlies the fascinating variety of phenomena that fall in the category of dissociations and disruptions of consciousness. In addition to the previously mentioned dissociations among memory measures in neurologically intact and amnesic patients and the characteristics of confabulation in brain-damaged patients (e.g., see Dalla Barba, 1993), there are such phenomena as blindsight (above chance ability of patients to guess the locations, presence or absence, or direction of motion of stimuli they do not feel that they see: Marcel, 1983; Weiskrantz, 1980), prosopagnosia (implicit recognition of faces that subjects do not appear to identify: Tranel & Damasio, 1985; Young & De Haan, 1992), agnosias (failing to recognize what an object is: Farah, 1990), dissociations of action and perception (e.g., normal motor adjustments of hand position in reaching when perception of the object is disrupted: Goodale, Milner, Jakobson, & Cary, 1991), neglect (e.g., failure to notice stimuli occurring on one side of space: Bisiach, 1988), and anosognosia (unawareness of deficit: Prigatano & Schacter, 1991). In the MEM framework, such phenomena occur as a consequence of selective breakdowns within subsystems or breakdowns in transactions between subsystems. Furthermore, disruptions within or between subsystems could come about in several ways and each should produce a somewhat different pattern of deficit, accounting for the wide range of symptoms observed.

For example, if P-2 processes were only partially disrupted (say, *placing* were disrupted), and assuming that R-1 or R-2 agendas could still engage in monitoring P-2, then the patient might have the experience of disordered perception (e.g., an agnosia) in which perception seems disorganized and piecemeal because parts of objects cannot be placed in relation to each other. Of course, the more component processes of P-2 that are disrupted, the more disorganized or incomplete the phenomenal experience. Blindsight may reflect a more general deficit within the P-2 subsystem, which disturbs the patient's ability to compute phenomenal representations of objects. Intact P-1 processes, however, would permit *locating*, *tracking* (motion detection), and some *resolving* of figure-ground information.

On the other hand, suppose that all the P-2 computations necessary to yield a representation (i.e., component processes of *identifying*, *placing*, *examining*, and *structuring*) are intact, but it is no longer possible for R-1 to monitor or control the relevant representations formed by P-2. For example, there may be a deficit in the *shifting* component process of R-1. Such a failed R-1/P-2 transaction would constitute a form of neglect or unawareness of a potential phenomenal object. Similarly, suppose that R-1 was unable to refresh representations in an area of P-2. *Refreshing* is a component process that prolongs activation—information is kept active for brief periods so that it remains highly available to be integrated with new incoming information. If components of a complex stimulus are not refreshed, they would fade quickly and not be available to be organized into stable, conscious percepts. Or, suppose reactivation of P-2 were disrupted. *Reactivation* is a component process by which information that has become inactive is revived to an active state; as suggested previously, anterograde amnesia could result from a disruption in the component process of reactivation (Johnson, 1992; Johnson & Chalfonte, 1994; Johnson & Hirst, 1991, 1993).

In cases of disrupted R-1 processes (e.g., *shifting, refreshing, reactivating*), if R-1 agendas were intact, then the patients would realize there was something wrong with their perception or with their memory. That is, they would have insight into their deficit because expectations generated by R-1 agendas would be experienced as unfulfilled; the *shift, refresh,* or *reactivation* signal would have been sent, but no return result received. Suppose instead, or in addition, the fault were in the agenda itself—it might be incapable of recruiting the *refreshing* or *reactivating* process. That is, no signal would be sent in the first place. Then the subject would not experience any unfulfilled intention (i.e., would not experience the absence of a return signal or an "error message"). In this case, the subject should show a type of unawareness of deficit or anosognosia. In short, how and which particular transactions were disrupted would determine the nature of both the deficit and whether the patient would or would not show insight about the deficit. Unawareness of deficit is a central issue for theories of consciousness, and we are only beginning to appreciate the implications of how specific anosognosia can be in particular cases (see Prigatano & Schacter, 1991).

Disrupted interactions between subsystems produce not only disorders of perception and memory, but also disorders of action and thought. For example, disruptions in interactions between reflection and perceptual subsystems could produce deficits in agenda-initiated action or conscious control. One such deficit might be the inability to voluntarily (i.e., through reflective agendas) activate motor and/or perceptual schemas, although they could still be activated through perceptual cues (Heilman & Rothi, 1985; McCarthy & Warrington, 1990). For example, a patient might not be able to mime how to use a hammer but might be able to show how to use it if given a hammer. Furthermore, given the critical role that interactions between R-1 and R-2 normally play in complex behaviors requiring planning, decision making, and problem solving, disruptions in either or both of these subsystems or in their interaction could have profound consequences. The growing body of evidence often subsumed under the idea of disrupted frontal lobe functions or "dysexecutive syndrome" (e.g., Baddeley, 1986; Stuss & Benson, 1986; Shallice, 1988) are the type of problems that should result from disrupted R-1/R-2 interactions.

Finally, consider the implications of the idea that R-1 and R-2 monitoring and control of each other are in some fundamental way optional. This suggests that we might be able to engage in quite complex cognition and behavior without necessarily observing ourselves doing so. Dissociative states like hypnosis and multiple-personality disorder (Kihlstrom, 1985; Schacter & Kihlstrom, 1989) may reflect a capacity that most individuals have not developed for suspending the normally constant and recursive interaction between R-1 and R-2 processes, or a capacity for restricting the representational domains across which monitoring and control are done.

All disruptions of cognition are potentially informative about the nature of consciousness. However, the disruptions of cognition that seem most like disorders of consciousness, as opposed to disorders of perception or thought, are those that involve deficits in transactions between subsystems.

CONCLUSIONS

This chapter has considered issues of consciousness from the perspective of the MEM framework. From this point of view, awareness is the consequence of monitoring between subsystems and would include, as Marcel (1988) suggested, internal as well as external events as objects of consciousness. Similarly, Bisiach's (1988) "C-2" consciousness referred to the idea that some parts or processes of a system have access to other parts or processes, permitting the "monitoring of internal representations" (p. 12). As noted earlier, this general idea is embodied in most conceptions of a central executive.

A single, central executive system, however, cannot alone account for the variety in types of consciousness one experiences or the complex patterns of breakdown in consciousness that are possible. Recognizing this limitation, Stuss (1991) posited three monitoring systems at different levels of mental processes. Similarly, within MEM, there is not a single executive, rather there are sets of agendas organized in such a fashion that monitoring and control are possible across subsystems. Specific qualitative characteristics of the resulting interactions will determine the nature of the conscious experience. For example, the difference between control and self-control depends in part on what is the object-level target of the control. Complex phenomenal experiences such as deliberation and choice depend on being able to represent and keep active two or more alternatives. Furthermore, the recursive quality that consciousness can have—for example, thinking about ourselves, thinking about ourselves thinking about ourselves, and so on—is possible because we

have two functional reflective subsystems capable of communicating (i.e., of mutual meta-processing) by taking turns as the object and meta-level. Thus, we do not need an infinite number of "homunculi," but only two cooperating subsystems to create the subjective experience of "layered" self-reflection.

The specific qualitative characteristics of our conscious experiences will depend on the nature of the information that is serving as the object level and on which subsystem is serving as the meta-level. All cognitive activity results in some sort of experience. But the subset of those experiences that have been most salient to philosophers and psychologists and are identified as Conscious experiences arise from the very structure of our cognitive architecture.

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