4 The Role of Narrative in Recollection: A View from Cognitive Psychology and Neuropsychology

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In this chapter, we investigate the role that narrative plays when people recollect their past—that is, when they provide a report of their own life anywhere in length from a single event to an entire life story. First, we outline a collection of processes, which include narrative reasoning, that come into play during recollection, noting that each appears to have a distinct neural substrate. Second, we examine the effects of neural damage that disrupts these cognitive processes. Based on this review, we conclude that narrative reasoning is one process among many used in recollection but probably the least well understood.

At the 32nd Annual Comparative Literature Symposium on Narrative and Consciousness: Literature, Psychology, and the Brain, there was a roundtable discussion at which I (DCR) sat on the stage with other speakers. I remember the incident and could produce a coherent narrative account about it. I might do this as if I were telling a story about someone else who participated in an event that I did not witness or even as an account of a fictional character; or, in contrast, I might do this with a sense of reliving my own past. For the latter case, I might use the English word *recollection* (Baddeley, 1992; Brewer, 1996) or, following Tulving (1983; Wheeler, Stuss, & Tulving, 1997), I might claim that I am in a special state of consciousness, called *autonoetic consciousness*, in which I am conscious now of a past conscious state. This chapter focuses on this latter case of recollection, of conscious recall of actual events rather than nonexperienced (Larsen, 1988) and fictive events. For now, to provide a hint of the type of argument to be made here, we will claim that narrative per se is not important to the difference between reliving a memory and not, although

narrative devices may be used to mark a sense of reliving explicitly in text; rather, this difference is more often caused by processes that involve visual imagery.

Prepostmodern psychologists like to define their terms, and so this paragraph might have been the place where we offered operational definitions of basic concepts. Instead, we use another solution to try to avoid solving our problems (and making new ones) through premature definition (Rubin, 1992). We will start with the most detailed and precise descriptions of our terms that capture what we believe is the essence of the processes at work, ones that are consistent with what we know about behavior and biology. If we are to benefit from evidence from different levels of analysis, we need to consider evidence from each level, usually in an iterative fashion. For example, one cannot look for the neural system or systems necessary to support narrative reasoning without some notion of what narrative reasoning is at the behavioral level. However, if one already knows fully what narrative reasoning is at the behavioral level, an investigation of the related biology can yield little useful information about behavior. If particular aspects of narrative reasoning were lost or damaged as a result of particular diseases or a particular kind of neural insult, we would want to try to group those aspects together in a description at the behavioral level. Similarly, if particular aspects of narrative reasoning appeared together at certain periods of development (Nelson, this volume), we might look for common neural development. There is no strict logic that suggests any relations will be present among the different levels; we are just attempting an iterative search for the most encompassing explanations. To begin this search (and for narrative reasoning it is just beginning) we provide a progress report on our attempt to describe the cognitive and neural basis of recollection, that is, the basis for the conscious recall of autobiographical memory into which the process of narrative reasoning must fit.

Systems Needed for Recollection: Behavioral Data

At least a handful of cognitive processes, each with a partially separable underlying neural system, are needed to provide a recollection (Rubin, 1995b, 1998). Here we consider an *explicit memory system* that encodes information in other systems, then later retrieves the separately stored information and integrates it into a memory; an *imagery system*, both because it is an important component in its own right and because it is a well-understood component to contrast with the less well understood narrative reasoning; a *language system*, because narrative reasoning is often considered a part of language and so distinguishing language from narrative is important if the independent effects of narrative are to be noted; and finally a *narrative reasoning system*. We use the

term *narrative reasoning* to posit a process that results in the product of narrative (cf. Bruner, 1986; Fitzgerald, 1996). When its use is restricted to narratives that are autobiographical memories, narrative reasoning is similar to what Habermas and Bluck (2000) call autobiographical reasoning. We could also consider emotions and imagery in other senses, such as olfaction and audition, but do not; less is understood about these processes, and in any case we wish to preserve our focus on narrative. The change from *processes* to *systems* or *components* is a conscious choice to emphasize that we are making an activity into a thing so that it can have a location (actually a widely distributed location but a location nonetheless) to make it easier to combine the behavioral and the neuropsychological data.

Explicit Memory

We posit an explicit memory system that combines information from the other systems. Psychologists and neuropsychologists have traditionally assumed such a central system, and there is good evidence for it. In the past, they have usually concentrated on this system alone in their theories of autobiographical memory, excluding a detailed analysis of the way in which the system combines information from other systems. The basic metaphor of a central process that puts things into places in memory, stores them there, and then finds them later dates back to at least the ancient Greeks, but it has reached its most well defined, sophisticated, and useful form in the computer models of cognitive psychology. There are two main differences from this basic metaphor we wish to make here. First, we do not assume that each memory is in one place; rather, we assume that it is distributed in the brain. While the memory is encoded or retrieved, its various locations are active at the same time; at other times, the locations remains dormant or are active in other memories or tasks. Thus the memory as a whole exists at one time but not in one place (Damasio, 1989). This abstract idea will become more concrete and detailed as we specify some of the systems in which the memory is located.

The second difference is that like many others (Damasio, 1989; McClelland, McNaughton, & O'Reilly, 1995; Mishkin & Appenzeller, 1987, June; Moscovitch, 1995; Schacter, 1996; Schmajuk & DiCarlo, 1992; Squire, 1987, 1992; Wheeler et al., 1997), we wish to use a central process that is both behaviorally and biologically plausible. We therefore look for one in the brain and use it as our metaphor instead of a metaphor of a wax tablet, attic, file cabinet, telephone switchboard system, cow's belly, computer, or any of a host of other metaphors that each capture some useful aspects of human memory (Roediger, 1980). Once the brain, or anything else, is accepted as a metaphor used to understand human behavior, discourse often becomes confused as to whether it is about the behavior or the metaphor. This is certainly the case

for the literature in cognitive psychology that accepts the computer as its metaphor. Here the confusion is worse. The brain is not only used as a metaphor, a conceptual nervous system invented to explain behavior; it is also the most likely physical location of the control of that behavior. For us, the substrate of recollection is the brain, and so in this chapter, having switched to terms such as *system* and *component*, we freely mix behavioral and neural evidence. The brain remains a metaphor to the extent we select freely from among its many properties or posit new properties to it in a way that is not strongly supported from studies of the brain itself. But the brain is more than a metaphor when the study of the brain provides an independent source of evidence. We include such evidence here.

One more observation about the explicit memory system will be noted now; others will be discussed later in the chapter when the biology of the system is considered. The processes performed by the central system in consciously retrieving, rather than encoding, a memory take a very long time. Undergraduates cued individually with words take about 10 seconds to produce an autobiographical memory; 70-year-old volunteers take almost twice as long (Fitzgerald & Lawrence, 1984; Robinson, 1976; Rubin & Schulkind, 1997). Undergraduates can begin pronouncing the same words used to cue the autobiographical memories or can decide whether a sequence of letters presented visually is a word or a pronounceable nonword in about a quarter of a second (Rubin, 1980), so retrieval in recollection may be very different in nature from other forms of retrieval psychologists have studied that take place on a much shorter time scale. On a cognitive level, cyclical retrieval (Conway, 1996; Conway & Pleydell-Pearce, 2000; Conway & Rubin, 1993), in which each successive retrieval serves as the cue for the next search, might produce such a delay; at a neural level, the delays are consistent with a nervous system that has closed-loop pathways among systems at some distance from each other that would take relatively long times to produce successive iterations. Thus the explicit memory system helps encode and integrate the information needed for recollection but does not store information itself.

Imagery

We describe the best understood of the remaining component systems needed for recollection, visual imagery, as a model of what might be done with narrative reasoning. Visual imagery is an analog system (Paivio, 1971; Rumelhart & Norman, 1986; Shepard, 1978) that shares many properties with visual perception. It can be broken down behaviorally and neurally into spatial and object components (see Rubin, 1995a, for a review).

Imagery has a central role in autobiographical memory for several reasons. First, it provides a powerful memory aid (Paivio, 1971, 1986, 1991), an ob-

servation that predates experimental psychological work on imagery by a millennium or two (Yates, 1966). Almost all mnemonic systems are based on visual imagery (Paivio, 1971; Yates, 1966). Most of the evidence for imagery's mnemonic role comes from its effects on long-term memory, but imagery can also be seen as an important aspect of our ability to manipulate visual information (Baddeley, 1986) and can even be seen as having most of its effects in this way rather than on long-term representations (Marschark, Richman, Yuille, & Hunt, 1987). That is, the imagery system should be viewed as a way not only to store information of a particular kind but also to consciously manipulate it.

Imagery is also important in autobiographical memory because of its role in increasing the specific, relived, personally experienced aspect of autobiographical memory. Specific, concrete details do more than improve memory. Concrete, easy-to-image details make stories seem more accurate, thoughtful, and believable (Pillemer, 1992, 1998; Pillemer, Desrochers, & Ebanks, 1998; Pillemer, Picariello, Law, & Reichman, 1996). Although vivid images do not guarantee accuracy (Winograd & Neisser, 1992), people act as if memory for details implies that the central points are remembered correctly. For instance, an eyewitness's testimony is more effective if details are included, even if they are irrelevant to the case (Bell & Loftus, 1989), and sensory details make people likely to judge that they did an action rather than just thought about it (Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981). You are more likely to decide that you really did lock the door rather than just thought you did if you can image yourself doing it. Chafe (1982, 1990) notes that language varies along the dimension of *involvement*. Involvement is marked linguistically by the use of first person and of dialogue, the same traits that are present when one seems to others to be reliving an experience or seeing it in one's mind's eye (Pillemer et al., 1998). Thus, evidence that the rememberer has an image is routinely taken as evidence for a relived, personally experienced, accurate autobiographical memory. In this role of increasing the specific, imagery interacts with language and narrative reasoning. The language of a journal article is abstract, general, low in imagery. A moving narrative usually is not. The experience of having an image is linguistically marked in narrative (Chafe, 1982, 1990; Pillemer et al., 1998) and has been at least from the time of Homer (Bakker, 1988, 1993).

In addition, imagery is central to two specific areas of the psychological literature on autobiographical memory. The first is the debate on flashbulb memories. The term *flashbulb memories* was coined by Brown and Kulik (1977) to talk about those memories for which your mind seems to take a permanent fixed picture of important events (see Conway, 1995; Winograd & Neisser, 1992, for reviews; Neisser, 1982, for a more constructivist view). Prototype flashbulb memories include knowing the details of where you were and what

you were doing when you first heard that President Lincoln (Colegrove, 1899), President Kennedy, or Martin Luther King (Brown & Kulik, 1977) was assassinated, or that Pearl Harbor was attacked (Neisser, 1982), or the space shuttle *Challenger* exploded (Winograd & Neisser, 1992). Imagery is a part of the flashbulb metaphor of taking a picture and an attempt to rename it as *vivid memory* (Rubin & Kozin, 1984), and it has effects on memory. The best predictor of the narrative recall of when people heard about the verdict of the O. J. Simpson trial was reported imagery (Bluck & Li, in press). Second, imagery enters in the autobiographical memory literature in cognitive psychology in the distinction between *field* and *observer* points of view, that is, whether one sees oneself in the memory or sees it from the original observer's viewpoint, a distinction that dates back at least to Freud (see Robinson & Swanson, 1993, for a review). One can distance oneself; one can change perspective by manipulating the image to take a different view. Thus we have two metaphors of imagery: one as a static, accurate picture that is most common in the autobiographical memory literature and another as a fluid mental-model image that can be seen from different points of view (both literally and figuratively), which is more common when psychologists try to understand imagery and how it differs from language (Paivio, 1971; Rumelhart & Norman, 1986; Shepard, 1978). The contrast between the two metaphors is one reason that the classic conflict between the view of memories as fixed and memories as constructions (e.g., Neisser, 1967) becomes so heated when applied to the autobiographical memory of eyewitness testimony and of recovered memories of sexual abuse.

Psychologists have viewed visual imagery as one process or faculty and consciousness, with its sense of reliving or recollection, as another. In contrast, most philosophers of mind have noted that a sense of reliving comes with a visual image (Brewer, 1996). In a recent study, we made a direct assessment of the relationship between the sense of reliving and visual imagery (Rubin, Schrauf, & Greenberg, 2000). We cued each of 50 undergraduates with 30 words and asked them to think of an autobiographical memory for each. Of the resulting 1,500 possible memories, 521 were rated as 6 or 7 on a 7-point scale of the extent to which the undergraduates felt that they were reliving the original event. The scale ranged from "1—not at all" to "7—as if were happening right now." Of these 521 highly relived memories only 8 were rated below 5 on a 7-point scale that used the same descriptions for the end points but asked the undergraduates if they could see the event in their mind. Thus, with only 8 exceptions out of 521 memories that were rated highly on the reliving scale, a strong visual image was reported. Moreover, undergraduates who had a high average value of imagery calculated over all 30 of their memories also tended to have high average values of reliving, showing that this might be a general style of recall. The relationship between the sense of reliving

and having a coherent narrative was much weaker. Consistent with this data is the strong sense of living (rather than reliving) that is present in dreams, often in the absence of a globally coherent narrative (Flanagan, this volume). Thus visual imagery appears to have a role in the conscious recollection of autobiographical memory that narrative reasoning does not have.

Language

By any linguistic, behavioral, or neuropsychological analysis, if language is considered as a thing it is not a unified, indivisible thing, but is understood in terms of components that can be identified. Usually these components include phonetics, syntax, semantics, and often some higher-level structure such as pragmatics or narrative. We first consider language to include structure at the level of the sentence and below and thus do not include narrative. We do this for three reasons. First, linguistics, which takes language as its object of study, tends to do so. Second, the study of aphasia, or language loss, usually makes this distinction as well. Third, there are many instances of narrative, such as mime and silent films, that do not use language in the usual sense. The first two reasons are for convenience. It is much easier to review and summarize a literature if one keeps the definitions of that literature. Later we will discuss the relationship of narrative reasoning and language.

One could easily claim that phonetics and syntax should have little effect on recollection. After all, on the one hand, phonetics and syntax might mainly help us decode and encode ideas for purposes of communication that are actually stored in some unspecified nonlinguistic form. On the other hand, there is a long tradition in philosophy and psychology from very different theoretical perspectives that claims we often (or always) think in words, that we talk to ourselves, and that this inner speech is equated with consciousness (Carruthers, 1996; Damasio, 1989; Ericsson & Simon, 1993; Skinner, 1974). Under this view, to have conscious, explicit memory we need phonetically and syntactically correct language. The argument for meaning is stronger. Semantics at the level of words and syntax plus semantics at the level of phrases and sentences have traditionally been seen as ways of interpreting and storing information about the world, at both a personal and a cultural level (e.g., Pavlov's second signal system [Popov & Rokhlin, n.d.]), with different languages fostering the formation of different realities (Lucy, 1992; Whorf, 1956). That is, from almost any perspective, language is a central aspect of our memory for events and its loss should have major effects on memory beyond the effects that must occur given the specific loss.

One way to look at the effect of language on autobiographical memory is to obtain autobiographical memories from people who know two or more languages, because they can provide information on how their different lan-

guages affect their memory. Most of the memories of the sequential bilinguals (i.e., people who learned one language after another) that we have tested come to the person in a particular language, much the way some people report that a dream comes to them in a particular language (Schrauf & Rubin, 1998, 2000). The language of the memory is often not the language in which the testing is done but is instead likely to be the language that was being used at the time of the event. For our current purposes, however, we are unable to assign this attribution to the phonetics, syntax, and semantics of the memory rather than to its narrative structure, the topic we turn to next.

Narrative Reasoning

Having provided a minimal description of the role of a central memory component, a visual imagery component, and a language component that operates at the level of the sentence and below, we turn to our main concern: narrative. Although there is no generally accepted definition of narrative in psychology (or perhaps anywhere else), psychologists generally agree on the properties of narrative. Schank and Abelson's (1995) view stresses the goal-directed nature of stories. Kintsch and Van Dijk (1975) note that a coherent narrative requires judgments of empathy, relevance, and theme. In cognitive psychological terms, Brewer (1980, p. 223) notes that "narrative discourse is discourse that attempts to embody in linguistic form a series of events that occur in time. . . . the cognitive structure underlying narrative is the mental representation of a series of temporally occurring events that are perceived as having a causal or thematic coherence."

Bruner (1986) views narrative as a mode of thought, a perspective that moves narrative from a description of text structure to a form of organization or process. In Bruner's words, the narrative mode of thought produces "good stories, gripping drama, believable (though not necessarily true) historical accounts. It deals in human or human-like intention and action and the vicissitudes and consequences that mark their course. It strives to put its timeless miracles into the particulars of experience, and to locate the experience in time and space" (p. 13). Brewer's idea of the cognitive structure that underlies narrative and Bruner's idea of a mode of thought, both of which move narrative from a structure present in language to the cognitive process of narrative reasoning, are most useful here.

Most researchers who have examined the form and content of autobiographical memory have focused on narrative structure; most claims for the importance of language in autobiographical memory have actually been claims for the importance of narrative. For example, Robinson (1981, 1996) integrated and extended theories of narrative from linguistics and folklore into cognitive psychology. Barclay (1986, 1996; Barclay & Smith, 1992) examined

the schematic nature of autobiographical memory and its relation to the local and general culture in which the individual is located. This approach produces the "conversational nature of autobiographical remembering" (Barclay & Smith, 1992, p. 82). Fitzgerald (1988, 1992, 1996) uses concepts such as "narrative thought" and "self-narratives" to account for autobiographical memory and its changes with mood and age. Schank and Abelson (1995) claim that "the content of story memories depends on whether and how they are told to others, and these reconstituted memories form the basis of the individual's *remembered self*" (p. 1). Using a psychoanalytic framework, Schafer (1981) and Spence (1982) note the importance of narrative. In a more humanistic approach, Freeman (1993, this volume) tied narrative to autobiographical memory, and Gergen and Gergen (1988) use narrative structure and communication to stress the social nature of remembering and the self. Narrative structure is central in recollection in groups (Hirst & Manier, 1996) and in the shared memories that define them (Bruner & Feldman, 1996). Creating narrative structure in recollection is a skill taught to children (Fivush, Haden, & Reese, 1996; Miller & Sperry, 1988; Nelson, 1993, this volume).

Narrative establishes a major form of organization in autobiographical memory, providing temporal and goal structure. Autobiographical memories are usually recorded as narrative; they are told to another person and to oneself. Inclusions and exclusions depend in part on the narrative structures used. If information is not central to the narrative structure, it is less likely to be remembered. For example, Brown and Kulik (1977) observed that reports of flashbulb memories tend to have canonical categories, such as the place, ongoing event, informant, affect in others, affect in self, and aftermath. Neisser (1982) countered that these may not be properties of flashbulb memories at all but rather properties of the narrative genre used to report any news. Thus Neisser claimed that these autobiographical memories are shaped by narrative conventions of the culture.

Finally, Habermas and Bluck (2000) use the term *autobiographical reasoning* to define the process by which autobiographical memories are combined into a coherent life story and related to the current self. They identify four components of autobiographical reasoning: *temporal coherence*, which involves the sequencing of events in time; *causal coherence*, which serves to explain both life events and changes in the narrator's personality; *thematic coherence*, which involves an analysis of common themes among many different memories; and the *cultural concept of biography*, the cultural mores that dictate the events that are incorporated into a life story.

Given this review and the lack of a formal definition of narrative, what can we take as a working definition of narrative reasoning so that we can examine its loss with neural damage? This is important here because of the lack of a universal definition and because such loss is not an established field of

study with its own name, as are the losses of visual or linguistic ability (i.e., agnosia or aphasia). Narrative reasoning is the ability to use structure above the level of the sentence, above the level at which most formal linguistic analysis and most studies of aphasia stop. It is the "mode of thought" (Bruner, 1986) used to describe particular incidents of goal-directed behavior in people and animate objects assumed to have humanlike motives. As a mode of thought it need not be expressed in language but can be expressed in forms such as pictures, cartoons, silent film, and mime and therefore could be tested using nonlinguistic means. Tests of narrative reasoning that have been used in the neuropsychological literature and that are therefore of use in our search include: (1) story comprehension as measured by recall or question answering, and, at a more difficult level, story comprehension when the goals or other structure have to be inferred; (2) showing understanding of a story by remembering or telling the same "important" parts as other people in your culture do; (3) showing appreciation of the goals, motives, and therefore mood or emotional tone of a story by analysis of recall protocols or by explicit questions; and (4) understanding nonliteral statements, jokes, or metaphors that require narrative-based leaps to understand, that is, leaps that you might explain to someone who did not "get it" with some form of a very short story. If the approach taken here is to be useful, we cannot define narrative reasoning, or any of the concepts used in this essay, in a fully satisfying way until we see which behaviors occur together and which behaviors are lost or remain intact together with neuropsychological insult (Rubin, 1992). The working definition and partial list of tests is our best attempt given the behavioral and neuropsychological data available and certainly will change if our understanding increases.

One final observation should be made in this section: People can have autobiographical memories and can recollect in ways that do not produce coherent narratives. One can have a vivid reliving of an isolated event or past sensory experience in the absence of any narrative structure. Brewer reviews the literature that shows that many philosophers of mind claim that a visual image is needed for recollection, but there is no consensus that a coherent narrative structure is. Therefore, it would not be surprising to find that a loss of narrative reasoning results in a loss of only some kinds of recollection and autobiographical memory.

Systems Needed for Recollection: Neuropsychological Data

Having outlined four component systems that are part of the set needed to have a recollection, we now ask what happens with loss to each. According to the consensus view of the neural mechanisms that support autobiographical

(or episodic) memory, the ability to consciously recollect past events is mediated by multiple systems spread throughout the brain (Damasio, 1989; Mayes & Downes, 1997; Mishkin & Appenzeller, 1987, June; Moscovitch, 1995; Rubin, 1998; Schacter, Norman, & Koustaal, 1998; Squire & Knowlton, 1995; Wheeler et al., 1997). Encoding of new experiences for later recollection is mediated by areas in the diencephalon and medial temporal lobes, especially the hippocampus and surrounding areas (Squire, 1987, 1992; Squire & Knowlton, 1995), mammillary bodies, and medial thalamus, which are part of what we have called the explicit memory system. The actual long-term storage of information for conscious recall is not in these encoding centers but in sense-specific locations in cortex as well as in cortical and subcortical areas that support emotion (Damasio, 1994). Retrieval of the stored information involves the frontal lobes, especially the right frontal lobe, but like the diencephalon and medial temporal lobes in encoding, the frontal lobes are not thought to store most of the information but rather the retrieval strategies needed to access it (Moscovitch, 1995; Wheeler et al., 1997). That is, the explicit memory system produces a memory that is localized in time and distributed in space.

When an autobiographical memory is recalled, information in widely separated areas of cortex are excited in time-locked, coactivated, or reverberating circuits similar to those that were active at encoding. That is at recall, a temporally and spatially extended pattern of neural firing, which uses feedback, results in a pattern of activation similar to that present during encoding. When autobiographical memory fails in amnesia, it is usually due to structures in or near the medial temporal cortex that prevent such coactivation from occurring (Hirst, 1982). Areas of the frontal lobes are the most recent addition to the explicit memory system probably because they are not the areas usually damaged in amnesia. Imaging studies have shown that areas in the right frontal cortex, especially areas near Brodmann's area 10, are involved when episodic, rather than semantic, memory searches are taking place (Buckner, 1996; Nyberg, Cabeza, & Tulving, 1996), whether or not the searches are successful. Whether these areas in the frontal lobes should be considered part of the explicit memory system, the narrative reasoning system, or both is not clear from the existing data.

Explicit Memory Loss

Given what is known about memory and amnesia, what should we expect with damage to the central explicit memory system? When the nervous system suffers damage, the loss of conscious explicit memory is different for events encoded prior to the insult (i.e., retrograde amnesia) and those after the insult (i.e., anterograde amnesia). In most cases the anterograde amnesia is more severe. Events prior to the insult benefit from encoding with an intact nervous

system, and those after do not. However, events after the insult are encoded and retrieved by a similarly damaged nervous system and those prior are not. For almost all kinds of damage to the central explicit memory system, the retrograde loss is temporally graded, with the most severe loss near the time of insult. The same can be true of anterograde amnesia, as in closed head injury, or the loss can exist the remainder of the patient's life, as in Korsakoff's syndrome. The temporally graded nature of retrograde amnesia has been attributed to general processes such as consolidation, in which older memories become more resistant to damage through any number of (often unspecified) biological changes, or, in more specific terms, because the separately stored components of the memory develop interconnections that no longer involve the hippocampal circuits and so are left intact when these circuits are destroyed. The temporally graded nature of anterograde amnesia has been attributed to recovery in the nervous system or because new areas are recruited over time to compensate for those that are lost (see Rubin, 1998, for a more detailed description).

Loss in Other Systems

What would happen with damage to the neural systems outside the areas that subserve explicit memory? That depends on their function. If they are primarily areas that are assumed to store and process the different kinds of information that are retrieved when a recollection occurs, then with the loss of access to the store of information the memory could not be formed. If an area helps organize or communicate the stored information but stores little or no information itself, the loss may be more in the coherence of the memory than in its contents, though following our initial metaphor of putting "things" into "places," disruption of the organization that affects the search process would result in "things" not being found.

But the loss should not be equal for memories stored before and after the insult, and the pattern should not follow that of loss before and after an insult that occurs in the explicit memory system. For memories of events that occurred after the loss, no information would be stored in the damaged areas, but coherent patterns might be able to be stored in the intact areas of the brain. If we assume that the neural structures in the explicit memory system that encode information remain undamaged, such patients could compensate for their deficits, allowing nondamaged areas of the brain that store and process information to play a greater role. For example, with loss of the visual imagery system memories might still be stored and retrieved without a visual component. In contrast, for memories stored before the damage information that was part of the coherent memory would be lost, and if the information was interrelated and used to cue other information, without the missing infor-

mation it might be impossible to "find" and reconstruct the remaining aspects of the memory into a coherent whole. This prediction is consistent with formal mathematical models of the nervous system (e.g., McClelland et al., 1995; Schmajuk & DiCarlo, 1992) as well as of neural models that stress coactivation of brain areas (e.g., Damasio, 1989, 1994), though with the exception of the research reviewed here, it is not explicitly stated or tested. Thus the retrograde amnesia would be more severe than the anterograde, with the actual severity of retrograde amnesia depending on how much information of a given kind is lost and how central it was to the memory (see Rubin, 1998; Rubin & Greenberg, 1998, for a more detailed description).

Imagery Loss

We know a great deal about the neural system that subserves vision. By assuming that at least the cortical areas of the visual system are included in the visual imagery system (Farah, 1988) we have a good idea about the neural location and functions of the visual imagery system. Moreover, these arguments can be extended to separate descriptive (or object) visual imagery from spatial imagery (Farah, Hammond, Levine, & Calvanio, 1988). Under this assumption, the neural substrate of imagery, like that of explicit memory and language, is not restricted to one small region of the brain but is spread over a large area with many identifiable subsystems.

What happens to people who make use of visual imagery throughout their lives, then suffer some trauma to the areas of posterior cortex that subserve it? Not all damage to visual cortex completely disrupts visual imagery. We therefore sought a subset of patients who could not access stored visual information. We were fortunate that this question had been addressed. Based on Kosslyn's (1980) detailed investigation of visual imagery, Farah (1984) developed a component model of visual imagery, which included a long-term visual memory for the store of visual information. To qualify as a case of *long-term visual memory loss*, the patient had to be able to (1) detect, draw, or describe the visual properties of an object that is present, demonstrating that their deficit did not stem from a motor or perceptual impairment, (2) demonstrate an inability to recognize an object on sight, by indicating either its name or its function; and (3) demonstrate an inability to draw an object from memory, although some stereotyped behaviors, like drawing simple shapes, were allowed. The first two criteria define associative visual agnosia; the last ensures that the problem is with the loss of memory of the visual information.

We tested our predictions by searching the literature for cases of long-term visual memory loss. We found 11 cases of long-term visual memory loss that met our three criteria (Rubin & Greenberg, 1998). Our results were striking. Of these 11 patients, all suffered from amnesia. That is, all suffered from

a general loss in autobiographical memory that extended beyond visual memory to all areas of memory. Although medial-temporal damage (i.e., damage to the central explicit memory system) may have accounted for some of the memory loss in some of these cases, the reports of the location of neural insult and the pattern of behavioral deficits suggest otherwise; out of the 7 cases that described their patients' memory deficits in detail, 5 suffered from severe retrograde amnesia with more moderate anterograde deficits. Moreover, the temporal gradient was absent in the 4 cases in which it was described (see Rubin & Greenberg, 1998, for a fuller treatment of these cases). With damage to the explicit memory system, the normal pattern is of more severe anterograde amnesia with a sparing of childhood memories usually noted. These results are consistent with what would be expected from the loss of stored information severe enough to prevent the formation of a memory based on the information that remains. Thus to our great surprise (because the loss of visual information had not been summarized as a cause of a different kind or, for that matter, any kind of amnesia) but consistent with what would be expected in general from most models (e.g., McClelland et al., 1995; Schmajuk & DiCarlo, 1992) and from the analysis of specific cases (e.g., O'Connor, Butters, Miliotis, Eslinger, & Cermak, 1992; Ogden, 1993) a severe general amnesia occurred with visual memory loss.

From this reanalysis of existing cases we concluded that the visual imagery system, at least as measured by its loss with a visual memory deficit, is necessary for autobiographical memory and amnesia can occur in ways other than damage to the explicit memory system. It would be have been consistent with the behavioral data to find a loss in reliving without a complete loss in autobiographical memory with less severe visual memory loss, but we could not find such reports in the literature. Whether a loss of reliving could occur with less severe loss of visual imagery is an open question.

Language Loss

What would happen then with the loss of language? The classification of kinds of language loss, or aphasia, has been the subject of substantial debate. Among the many classifications of aphasia that can be made, the most important here makes the distinction between those aphasics who could produce language intelligible enough to have been tested and reported in the literature and those who could not. This exclusion is not for any logical or scientific reason but only because we could not find aphasics who were tested on autobiographical memory or on similar tasks using nonlinguistic means. The patients who could be tested were usually Broca's or nonfluent aphasics, who generally speak in short bursts of three or four words and who typically struggle to retrieve the proper word for a particular idea, or they were conduction aphasics, who suffer

in part from a deficit of inner speech and lose the ability to "hear" words in their minds. The patients who could not be tested were usually severe cases of Wernicke's or fluent aphasia, who speak as fluidly and as easily as people without aphasia but pepper their speech with repetitions, neologisms, and irrelevant words.

The existing research indicates that aphasics manage to produce remarkably well formed autobiographical memories. We found two autobiographies written by aphasics (Luria, 1972; Wulf, 1979). Wulf's (1979) narrative begins with her memories of her stroke, then continues with her perspective on her impairment six years later; she repeatedly states that her speech impairment far outweighs any intellectual difficulties. Luria's patient Zasetsky produces thousands of pages of fluid, emotional narrative that describes his "shattered world" and his inability to use language in everyday life: "When a person has a serious head wound . . . he no longer understands or recognizes the meaning of words right away and cannot think of many words when he tries to speak or think" (Luria, 1972, p. 75). Even conduction aphasics do not typically manifest any major memory deficits; for example, E.B., a conduction aphasic, remembers his first day at the hospital and describes his sensations upon waking: "Began to see white and hear voices and hospital sounds and then could see nurse and young doctor above me, talking to me, asking me my name. Felt stunned, numb, and weak all over. Tried to move but nothing to move, tried to talk but could only make slurred sounds" (Levine, Calvanio, & Popovics, 1982, p. 394). Thus although aphasia can cause severe, obvious, and extensive changes to an affected patient's speech, if the patient is given a long time and a choice of modalities in which to record the memory aphasia does not necessarily prevent that patient from producing well-structured autobiographical memories. We therefore conclude that the loss of language in aphasia does not play a vital role in the encoding and retrieval of autobiographical memories. Aphasics who can find words and produce sentences slowly and with great effort produce coherent life stories with the same difficulty.

This broad statement comes with two caveats. First, we found no patients who suffered from a complete inability to use language in any modality. Therefore, none of the patients described earlier are analogous to the visual memory loss patients. If we could find such patients—and if we could find reliable, nonlinguistic ways of testing their autobiographical memories—we might uncover different results. Second is the rare form of aphasia known as semantic dementia, to which we can now turn.

One specific type of fluent aphasia presents an important exception to the generalization that aphasia causes only minor problems with autobiographical memory. A rare disorder known as semantic dementia, or progressive fluent aphasia (Hodges, 1992; Hodges, Patterson, Oxbury, & Funnell, 1992), often results in a severe impairment of autobiographical memory. Although perhaps

better conceived as a disorder of semantic memory rather than of language, it is generally placed under the heading of a language disorder, as its most obvious effects are on the production and comprehension of language. Patients with this disorder suffer from a progressive anomia and loss of word comprehension, though their phonological and syntactical abilities are generally spared (Hodges, 1995); specifically, they suffer from a progressive loss of knowledge about the world (Graham, 1999). These patients manifest widespread damage to temporal neocortex, although the medial temporal structures of the explicit memory system generally appear intact, at least in the early stages of the disease (Graham & Hodges, 1997; Harasty, Halliday, Code, & Brooks, 1996). Here we follow the literature and assume most loss of memory is for the meaning of individual words.

Although early investigations suggested that the disorder spared episodic memory (Hodges et al., 1992), more recent work shows that semantic dementia may result in retrograde amnesia (Graham & Hodges, 1997; Hodges & Graham, 1998; Snowden, Griffiths, & Neary, 1996). Patients with semantic dementia performed near the level of controls when asked to retrieve recent memories but performed more poorly than even an Alzheimer's group when asked to retrieve early memories. A more detailed investigation of a single patient, who was given words and asked to produce a memory for each, yielded a similar result: the patient produced mainly superficial and impoverished memories, and most of the detailed, temporally located memories came from the two years prior to testing. Studies that attempt to separate a loss of autobiographical memory from a loss of recollection with a preservation of the facts of the autobiographical memory may be possible because semantic dementia does not produce a complete amnesia and is a progressive disease and so varies in severity.

On both a behavioral and neurobiological level, the deficits in semantic dementia patients parallel those with visual memory deficit amnesia. Patients with visual memory deficit amnesia can copy a drawing of an object, even if they cannot identify it; semantic dementia patients can repeat words, even if they no longer know what those words mean (Hodges et al., 1992). In semantic dementia, the presentation of a word no longer calls to mind its meaning; in visual memory deficit amnesia, the presentation of an object no longer calls to mind its meaning. Both disorders stem from neocortical pathology (of either the visual imagery or the language systems) in the absence of medial-temporal trauma to the explicit memory system; in both disorders, this damage results in the loss of information crucial to autobiographical memory; and in both disorders, the patients suffer retrograde amnesia with relatively mild anterograde deficits. The retrograde memory of semantic dementia patients is less severe, with a sparing of recent memories. This is opposite to the loss with damage to the central explicit memory system and may differ from the visual memory deficit loss only in degree. Overall, the contrast between minor loss

in autobiographical memory functioning with most aphasia and major loss in autobiographical memory functioning with loss in the visual imagery system and with loss in semantic dementia is striking. Also striking is the parallel between loss in the visual imagery system and semantic dementia. Because semantic dementia does not affect primary sensory association cortices, our summary goes beyond the claims that such areas are necessary for recollection (Damasio, 1989) and offers a different interpretation. It appears that substantial amounts of stored information are necessary for recollection, whether or not they are sensory, because their loss removes information necessary to have the memory at all.

There exist two theoretical interpretations of the pattern of autobiographical memory deficits observed in semantic dementia. In the first interpretation the hippocampus is not involved in the recall of older memories (Graham, 1999; Graham & Hodges, 1997; Hodges & Graham, 1998), whereas in the second interpretation it is (Moscovitch & Nadel, 1999). In either case, both interpretations are consistent with the view presented here in that the loss that causes the retrograde amnesia is a loss in information stored in neocortex, that is, in information stored outside the explicit memory system. The extended consensus view presented here is neutral with respect to this debate in that either interpretation could be adopted as part of the consensus view of hippocampal function without affecting our discussion of what the rest of the brain is doing in autobiographical memory. One observation by Moscovitch and Nadel (1999) suggests another possible difference between semantic dementia and visual memory deficit amnesia and thus between the role of vision and semantic information. In visual memory deficit amnesia, the loss of visual information causes a loss of autobiographical memories that is often complete and thus does not depend on whether the stimulus used to cue the memory was visual or verbal. Moscovitch and Nadel mention a patient with semantic dementia who could not provide autobiographical memories to word cues but who could provide them to visual cues. Thus, for this patient, coactivation circuits could be maintained for at least some autobiographical memories when the initial cuing was not through the damaged system. It is not yet clear whether this difference is a matter of the severity of the damage or a fundamental difference between the role of language and the role of vision in autobiographical memory. Because Moscovitch and Nadel's patient could talk about the memories cued with pictures, however, it follows that nonlinguistic stimuli could activate stored semantic information.

The Sparing of Narrative Reasoning in Aphasia and Other Disorders

Before leaving the topic of aphasia, we need to emphasize the difference between a loss in language as defined by phonetics, syntax, and semantics and the loss of narrative reasoning. For this section we exclude semantic dementia

because we could not find data on narrative reasoning for these patients. With few exceptions, aphasics' narrative reasoning abilities remain relatively intact. First, in spite of their clear difficulties with comprehension, aphasics frequently comprehend narratives at near-normal levels. When asked to retain narratives, aphasics frequently retain almost as much information as healthy controls (Hough, 1990; Wilcox, Davis, & Leonard, 1978); furthermore, both groups tend to remember the same elements, and properly identify themes and details (Stachowiak, Huber, Poeck, & Kerschensteiner, 1977). Context clues help aphasics overcome their comprehension deficits and allow them to understand and encode more information than they would if the data were presented in the form of distinct, individual sentences (Pierce & DeStefano, 1987; Wilcox et al., 1978). Aphasic patients performed at near-normal levels when the story text was combined with pictures (Huber & Gleber, 1982), a finding consistent with organization from imagery and narrative reasoning combining to compensate for losses in language. Consistent with these findings, standard tests of aphasia (which generally examine comprehension of phrases and sentences) do not reflect the patients' narrative abilities; for example, aphasics' paragraph comprehension scores do not correlate with their scores on the Boston Diagnostic Aphasia Examination and the Token Test, two standard tests of aphasia (Brookshire & Nicholas, 1984; Wegner, Brookshire, & Nicholas, 1984).

An analysis of aphasics' narrative production also reveals substantial preservation. On the surface, most aphasics' narratives again reflect their language impairments, manifesting severe problems with grammar and word retrieval (Freedman-Stern, Ulatowska, Baker, & DeLacoste, 1984). A closer examination, however, reveals that aphasics' narratives frequently preserve discourse structure. Aphasics retained an ability to judge relevance; like healthy subjects, they reported more relevant details than peripheral details (Ernest-Baron, Brookshire, & Nicholas, 1987). Fluent aphasics performed more poorly, manifesting a greater tendency to confabulate and embellish (Berko-Gleason et al., 1980; Glosser & Deser, 1990), though they still generally preserved narrative structure (Freedman-Stern et al., 1984). Thus, for one patient, M.A., "a detailed description of the language of this aphasic at a sentence and discourse level revealed preservation of discourse structure through proper use of cohesive devices despite severe disruption of linguistic structure at a sentence level" (Freedman-Stern et al., 1984, p. 181).

When aphasics do perform poorly on tasks that examine narrative structure, they tend to make errors of quantity, not quality (Freedman-Stern et al., 1984; Ulatowska, Freedman-Stern, Doyel, Macaluso-Haynes, & North, 1983). Aphasics typically manifest two deficits, both of which involve the loss of information: first, their stories are less complex than those of healthy subjects, and second, they include less information overall (Berko-Gleason et al., 1980; Ulatowska, North, & Macaluso-Haynes, 1981), though occasionally this effect is not significant (Ernest-Baron et al., 1987).

Fluent aphasics, that is, those who talk fairly easily in complete, seemingly syntactically correct sentences but include few content words, present the only exception to the quantity-versus-quality claim. On nearly every test of narrative ability, fluent aphasics perform more poorly than nonfluent aphasics do. Although some studies fail to separate their patients into these subcategories, those that do report that fluent aphasics generally confabulate more than either healthy subjects or nonfluent aphasics (Berko-Gleason et al., 1980). Thus our generalizations about narrative reasoning loss versus aphasia need to be tempered.

Not only is narrative reasoning not affected in most forms of aphasia; it is also difficult to disrupt in general. A wide range of populations, including those with affective disorder, Alzheimer's disease, closed head injury, developmental disabilities, Korsakoff's amnesia, language impairment, metabolic disorder, multi-infarct dementia, and schizophrenia, remember and forget the same parts of stories as do healthy controls. They may recall much less immediately after hearing a story and forget what they learned faster, but the parts of the story that are most and least likely to be remembered are the same (Bacon & Rubin, 1983; Rubin, 1985; Rubin, Olson, Richter, & Butters, 1981; Schultz, Schmitt, Logue, & Rubin, 1986). The robustness in the ability to appreciate narrative in the presence of other impairments helps isolate narrative reasoning from other aspects of behavior lost with these disorders.

Narrative Reasoning Loss

Narrative reasoning or, at least, the aspects of narrative reasoning that have been measured in the neuropsychological literature are exceedingly hard to disrupt. As just reviewed, they do not fail with most forms of localized brain damage, and this is one reason that it is hard to describe the effects of the loss of narrative reasoning. We searched in the neuropsychological literature for cases of patients who had lost narrative reasoning, or an aspect of it. We did not find studies of patients who were grouped together because their presenting behavioral symptom was a difficulty in narrative reasoning and then look for the location of the underlying damage, as we did with amnesia, agnosia, and aphasia. Rather, we found studies of patients who were grouped together because they had damage somewhere in large areas of the brain, studies that demonstrated that these patients tended to have deficits in aspects of what we are calling narrative reasoning. Another reason for the lack of studies of narrative reasoning loss rather than those of amnesia, agnosia, and aphasia appears when one considers what a severe, and therefore easy to measure, loss in narrative reasoning would imply. Consider a person who has difficulty in understanding complex stories, the nonliteral intent of a story, statement, or metaphor, and the likely emotional state of the protagonist. Such a person would be difficult to test. He or she might even be classified as demented, if

we group narrative reasoning loss with other cognitive effects. Such a broadly described deficit is less likely to have a simple or localized cause, and thus it is less likely to lead to information about localization of function in the nervous system and less likely to be studied at all. Although there is a relative lack of studies, those that do exist are informative and point to some localization of function.

If narrative reasoning remains unimpaired in cases of aphasia and in many other clinical populations and so may be a function that can be lost in isolation, what is its neural basis? Both imaging studies (Bottini et al., 1994) and neuropsychological investigations (Goodglass, 1993) localize narrative abilities (at least in part) to the right hemisphere or the frontal lobes, although Wernicke's aphasics (who have left-hemisphere damage) do perform much like right-hemisphere patients (Freedman-Stern et al., 1984). Right-hemisphere patients manifest a series of deficits that reveal difficulty comprehending speech at the discourse level; though they retain the ability to speak "with appropriate phonology and syntax" (Goodglass, 1993, p. 147), they perform poorly on the sorts of judgments that narrative reasoning tasks require (but see Brookshire & Nicholas, 1984; Rehak et al., 1992, for conflicting views). Right-hemisphere patients frequently fail to judge the intent of nonliteral statements, and offer literal or nonsensical explanations (Brownell, Potter, & Bihrle, 1986; Wilcox et al., 1978). Along the same lines, right-hemisphere patients have substantial difficulty interpreting metaphors (Brownell, Simpson, Bihrle, Potter, & Gardner, 1990; Winner & Gardner, 1977) and drawing inferences from stories (Beeman, 1993), especially stories in which the utterances are literally false and require nonliteral interpretations (Kaplan, Brownell, Jacobs, & Gardner, 1990). Right-hemisphere patients also manifest a substantial impairment of their ability to organize and reorganize data. Hough (1990) showed that right-hemisphere patients had significant difficulty reproducing narratives when the theme was withheld to the end; left-hemisphere patients and healthy controls performed at ceiling levels, either because they were able to divine the theme or because they could hold the story information in memory and reorganize it after the theme was presented.

There may be one component of what we could consider narrative reasoning that might be separated behaviorally and neurally from the rest. The temporal order of autobiographical memory is a well-studied topic (Friedman, 1993; Larsen, Thompson, & Hansen, 1996). It appears that unlike many other aspects of autobiographical memory, the dating and sequencing of events is not an integrated property, like visual imagery or emotion, but rather is calculated using a variety of strategies (Brewer, 1996). Aspects of the relevant sequencing ability appear to be localized in the right parietal lobe (see Watson, 1994, for a review).

In short, right-hemisphere-damaged patients frequently lose their ability

to appreciate context, presuppositions, affective tone, and the significance of the theme. Given the importance of these abilities to autobiographical memory, we might expect that their loss would induce at least some form of amnesia, but the studies of right-hemisphere patients do not report such deficits. The absence of such reports is significant in itself; if amnesia existed, it would almost certainly have been reported. However, these patients may often appear demented. Although the neural structures that subserve their memories might be intact, these patients might not be able to access those memories, and, if the memories are accessed, the patients might not be able to present them in a clear, coherent way. The difficulty in distinguishing between whether the memories can be retrieved but not communicated may contribute to the lack of reporting on autobiographical memory in the literature.

Frontal-lobe damage has clearer effects on autobiographical memory. Damage to the frontal lobes, particularly the right orbitofrontal regions, can lead to confabulations (Baddeley & Wilson, 1986; Moscovitch, 1995; Moscovitch & Melo, 1997; Schacter et al., 1998). Moscovitch (1989) has proposed a definition of confabulation that is adapted in part from Talland (1965); for our purposes, the following excerpt is most relevant:

> A confabulation is (a) typically, but not exclusively, an account, more or less coherent and internally consistent, concerning the patient. (b) This account is false in the context named and often false in details within its own context. (c) Its content is drawn fully or principally from the patient's recollection of his actual experiences, including his thoughts in the past. (d) Confabulation reconstructs this context, modifies and recombines its elements, employing the mechanisms of normal remembering. (e) This method is presented without awareness of its distortions or of its inappropriateness. (p. 134)

According to this definition, confabulations are (1) autobiographical; (2) inaccurate; (3) based upon actual memories, including memories of past thoughts (which may be inaccurately recalled as actual events); (4) cobbled together from data from disparate times; and (5) usually uttered without any awareness of their inaccuracy. Although confabulations do appear to be based on fragments of real experiences (Baddeley & Wilson, 1986; Moscovitch, 1989; Schnider, Gutbrod, Hess, & Schroth, 1996; Schnider & Ptak, 1999), some confabulations, occasionally called secondary confabulations, appear to be attempts to rationalize implausible statements that the patient has already made (Moscovitch, 1989).

Confabulating patients appear to be impaired on some but not all of Habermas and Bluck's (2000) four components of autobiographical reasoning. First, confabulators clearly have difficulty preserving the *temporal sequence* of their autobiographical memories, as they may combine statements from the

past and the present when they are talking about their current lives; for example, they may state that they got married four months ago and then claim that they have four children over the age of 20 (Moscovitch, 1989). Because of this tendency, the confabulators' autobiographical memories may contain inaccurate or implausible *causal sequences*. They generally seem untroubled by the absence of causal coherence in their narratives; however, if their attention is called to their errors, they may engage in secondary confabulations in an attempt to restore this missing causal structure. Thus they may still be able to weave together a possible (if implausible and inaccurate) story from the discontinuous memories they have retrieved. It is unclear whether the *thematic coherence* of their narratives is affected; however, if confabulators generate inconsistent, erroneous, disorganized memories, it will likely be difficult for them to identify common themes among those elements.

We can now return to the question of the relation of narrative reasoning and language. Can narrative reasoning be seen as part of language? In the light of the information reviewed here, this seems to be a definitional problem. If you are a linguistic imperialist, all levels of structure used to produce coherent text can be seen as language. Under this view, however, phonetics, syntax, semantics, and narrative reasoning must be seen as partially separable components that can each be used for their own purposes without the others.

Discussion

There is much to be gained by integrating over levels of analysis and therefore over the disciplines that try to understand those levels. Such integration was a driving force in the formation of disciplines such as cognitive science in the 1960s and more recently of cognitive neuroscience. Here the goals have been more modest. We tried to take a particular problem, the role of narrative reasoning in recollection, and see what could be gained from an attempt at integrating the psychological and neuropsychological literatures. In doing this, we started with the view that recollection and even narrative reasoning might have widely distributed neural bases in the brain. Brain-imaging technologies tend to find the most active area or areas for each task and thus focus on a narrow localization. Here we tried to go against this trend and emphasize the distributed neural basis of cognitive functions, something that holds for integrated behaviors as "simple" as naming an object (Watson, Welsh-Bohmer, Hoffman, Lowe, & Rubin, 1999) and as global as the changes that accompany aging (Rubin, 1999).

Where does this view of recollection and narrative reasoning leave us? First, it makes sense in terms of behavior and underlying biology to view au-

tobiographical memory as an integration of at least a handful of distinct skills, processes, or systems, of which narrative reasoning is just one. Second, if systems with a physical basis in the brain are taken as the main metaphor, then we gain a good deal of knowledge from neuroscience and especially from deficits in behavior that come with neural damage. Third, by reviewing published studies of neural damage in people in the context of what we already knew about behavior in people without such damage we found (1) that the loss of information, either visual or semantic, produces amnesia that extends beyond the modality of loss, (2) that the loss of language ability that results in the laborious production of speech results in the laborious production of autobiographical memories but little other loss, and (3) that narrative reasoning loss is separate from other kinds of language loss and its effects on autobiographical memory remain to be studied.

There are dangers and concerns with this approach. We do not want to replace the reification "autobiographical memory" with the reification of a handful of systems and do no more than this. In addition, our existing definitions of imagery, language, narrative, and memory must be renegotiated to integrate the information from all levels; the behavior alone, or the neuroscience alone, cannot define such terms if the approach used here is to be fruitful. Of most concern is the potential to lapse into a reductionist view of concepts such as imagery, language, and narrative, which are cultural or social products as well as neural ones. This concern holds for most concepts in psychology. But this is especially salient for the terms of interest here, which are central to the transmission of culture.

But what of the prospects of understanding narrative, a key concept that integrates this volume? Here we are in a much more primitive state than we are in other areas. We see two main reasons for this that have different implications for future work. First, it is not at all clear that what we are calling narrative reasoning is a unified function at the behavioral or neural level. We were unable to find studies that show that a loss in one of the measures that we are using as an indicator of narrative reasoning is accompanied by a loss in others. If we could describe which indicator tasks fail or are spared in the same patients, some basic classification could begin. A clear theory of narrative reasoning at the behavioral level would be a great aid in formulating such indicator tasks. The combination of having neither a behavioral nor neuropsychological theory or classification makes the investigation more difficult but does indicate what work could be done. We need a set of possible functions that we would consider to be part of narrative reasoning. Next we need to see if these functions or subsets of them fail or are spared in the same patients. To do this correctly requires that the tasks formulated to test the functions be graded in difficulty so that the difficulty of the task itself, in-

dependent of any narrative reasoning function, does not determine the results. Such work is common in many areas of psychology, but it is technically difficult.

Second, narrative reasoning may be more widely distributed in redundant ways in the brain than the other systems studied and so may just be less likely to be damaged unless there is diffuse and substantial brain damage, damage that would produce a host of symptoms unrelated to narrative. If different aspects of narrative reasoning evolved in different epochs and partially overlaid existing aspects that were in other brain structures (a common view in brain evolution), then this might occur. A way to study this would be to ask what behaviors in other species look like aspects of what would be considered narrative reasoning in people. If this is the state of nature, it will be more difficult for the approach tried in this chapter to produce knowledge about the localization of narrative reasoning, because the role of partially redundant subsystems will have to be understood.

But even with the paucity of findings on what aspects of narrative reasoning go together behaviorally and on the localization of its neural substrates, much has been learned by just asking the question of how narrative reasoning would fit into a behavioral and neural theory of recollection. We have noted gaps in our knowledge of the biological basis of autobiographical memory. We have made a distinction between and offered support for two kinds of systems. First are systems where damage causes a loss in autobiographical memory for events (and thus for recollection) that extends well beyond what would be expected by damage to the system itself (e.g., visual memory deficit amnesia and semantic dementia). Second are systems where damage causes a loss that does not extend beyond the system (e.g., most aphasias). The neuropsychological data do not exist to allow us to ask which kind of system best describes narrative reasoning, and neither the neuropsychological nor the behavioral data indicate whether narrative reasoning includes its own store of information.

We have provided evidence to support the usefulness of viewing memories as distributed across systems and retrieved by activating their component information at the same time. Under this view, narrative reasoning could just be another system or it could be central to the frontal lobe component of the explicit memory system as a guiding organization used in retrieval searches (but see Rubin, 1999, for some complications). The localization of narrative reasoning is ambiguous enough to allow either interpretation. Most important, we have tried to demonstrate that combing the neuropsychological and behavioral evidence on recollection reveals possibilities and limits speculation in ways that neither can do alone. With recent technological advances that allow localization of damage in patients to be known more accurately and that allow the localization of activation in various tasks in people without any known

damage, more information about the neural basis of human behavior is becoming available. For research on autobiographical memory and recollection, the relative role of the brain as a metaphor is shrinking in relation to the role of the brain as physical entity about which a great deal is known. Sophisticated behavioral descriptions and analyses of complex behaviors such as narrative reasoning will be needed if information from these technologies is to be of use to questions like those raised in this chapter and in the rest of this volume.

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