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The Construction of Autobiographical Memories in the Self-Memory System

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The authors describe a model of autobiographical memory in which memories are transitory mental constructions within a self-memory system (SMS). The SMS contains an autobiographical knowledge base and current goals of the working self. Within the SMS, control processes modulate access to the knowledge base by successively shaping cues used to activate autobiographical memory knowledge structures and, in this way, form specific memories. The relation of the knowledge base to active goals is reciprocal, and the knowledge base "grounds" the goals of the working self. It is shown how this model can be used to draw together a wide range of diverse data from cognitive, social, developmental, personality, clinical, and neuropsychological autobiographical memory research.

Autobiographical memory is of fundamental significance for the self, for emotions, and for the experience of personhood, that is, for the experience of enduring as an individual, in a culture, over time. As a consequence autobiographical memory is researched in many different subareas of psychology, for example, cognitive, social, developmental, clinical, and neuropsychology to name only some of the most prominent. However, research findings and research practice from these subdomains are, for the most part, isolated and do not inform one and other. The reason for this is that autobiographical memory is highly complex and presents different types of problems and issues to researchers from different traditions. For instance, the neuropsychologist is often concerned with the underlying neuroanatomy, as well as other aspects of neurobiology, that mediate autobiographical remembering (see Conway & Fthenaki, 2000). In contrast, the personality theorist is interested in how various personality and attachment styles selectively increase accessibility to groups of memories (e.g., Bakermans-Kranenburg & IJzendoorn, 1993; McAdams, Diamond, de Aubin, & Mansfield, 1997; Mikulincer, 1998; Strauman, 1996; Woike, 1995), and the developmental psychologist is focused on the nature of infant and child memory, young adult memory, as well as the conundrum of childhood amnesia observed in adults (Fivush, 1993; Habermas & Bluck, in press; Howe & Courage, 1997; K. Nelson, 1993; Pillemer & White, 1989). Yet other approaches consider the relation of emotion and autobiographical memories (e.g., Levine, Stein, & Liwag, 1999), culture and memory (e.g., Han, Leichtman, & Wang, 1998; see too the collection of readings in Pennebaker, Paez, & Rime, 1997), and the cognitive psychologist investigates the representation of such memories and their availability over the life span (e.g., Conway, 1990a, 1996a, in press; Conway & Rubin, 1993; Rubin, Rahhal, & Poon, 1998; Thompson, Skowronski, Larsen, & Betz, 1996). Our purpose in this article is to present a model of autobiographical memory that encompasses all of the foregoing areas and that, we believe, can serve as a useful framework in which to draw together into an at least partly theoretically coherent form, the diversity of autobiographical memory research.

A fundamental premise of our approach is that autobiographical memories are transitory dynamic mental constructions generated from an underlying knowledge base. This knowledge base, or regions of it, is minutely sensitive to cues, and patterns of activation constantly arise and dissipate over the indexes of autobiographical memory knowledge structures. Such endogenous patterns of activation may not coalesce into "memories," nor do they necessarily or even usually enter into consciousness; instead this most often occurs when the system is in "retrieval mode" (Moscovitch, 1995; Schacter, Norman, & Koustaal, 1998; Tulving, 1983). Thus, we propose that the instantiation of memories in consciousness and their incorporation into ongoing processing sequences is modulated by central or executive control processes. Control processes implement plans generated from the currently active goals of the working self, and, somewhat ironically (see Wegner, 1994), one of their main functions may be to inhibit constantly occurring endogenous patterns of activation in the knowledge base from entering consciousness where their usual effect would be to interrupt current processing sequences. In the following sections we first describe our conception of the autobiographical knowledge

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base and structures within it (Part 1), and next we turn to an account of the self and memory (Part 2), followed by sections on memory construction (Part 3) and the neuroanatomy of autobiographical memory (Part 4). In a final section (Part 5) the model is applied to a wide range of autobiographical memory phenomena including life span development of memory, impaired recall in depression, and intrusive recollection in posttraumatic stress disorder (PTSD).

Part 1: Autobiographical Knowledge

One striking feature of autobiographical memories is that they always contain knowledge at different levels of specificity. In our work (S. J. Anderson & Conway, 1993; Conway, 1990a, 1992, 1996b; Conway & Bekerian, 1987a; Conway & Rubin, 1993) and in research from other groups (Barsalou, 1988; N. R. Brown, Shevell, & Rips, 1986; Linton, 1986; Schooler & Herrmann, 1992; Treadway, McCloskey, Gordon, & Cohen, 1992), three broad levels of specificity have been identified: lifetime periods, general events, and event-specific knowledge (ESK).[1] In order to illustrate this, consider the following memory (from Conway, 1996c):

> My own memory for the declaration of the second world war, from September 1939, occurred when I was aged 6 years and 6 months. I have a clear image of my father standing on the rockery of the front garden of our house waving a bamboo garden stake like a pendulum in time with the clock chimes heard on the radio which heralded the announcement. More hazily, I have an impression that neighbours were also out in the adjoining gardens listening to the radio and, although my father was fooling around, the feeling of the memory is one of deep foreboding and anxiety. I have never discussed this memory with anyone and very rarely thought about it. (G. Cohen, personal communication, August 1994)

In this example a lifetime period is specified (*when I was six*) with associated details characteristic of the period (father, neighbors, radio, etc.). The general event is *playing in the garden,* and ESK details are also described (the swinging bamboo stake, clock chimes, and the feeling of anxiety). This pattern of interlinked autobiographical knowledge constructed into a memory is highly characteristic (if not defining) of the recall of specific autobiographical memories (cf. Conway, 1996b, and Barsalou, 1988) that never seem to be solely of only one type of knowledge. Instead, ESK details are contextualized within a general event that in turn is associated with one or more lifetime periods that locate the more specific knowledge within an individual's autobiographical memory as a whole. The relations between these different types of knowledge and how they are combined into memories is considered later. Next we examine what types of knowledge are characteristic of the different levels of specificity.

Lifetime Periods

Lifetime periods, such as *when I was at school, when I was at University, working for company X, when the children were little, when I lived with Y,* and so on, represent general knowledge of significant others, common locations, actions, activities, plans, and goals, characteristic of a period. Lifetime periods also name distinct periods of time with identifiable beginnings and endings, although these may be fuzzy rather than discrete. The content of a lifetime period represents *thematic* knowledge about common features of that period (Conway, 1992, 1996b; Linton, 1986), as well as *temporal* knowledge about the duration of a period. For any given chronological period there may, however, be a number of lifetime periods. For instance, *when I lived with Y* may overlap in time with *when I worked at X* but the thematic knowledge of the two time periods may index different parts of the autobiographical knowledge base (Barsalou, 1988; N. R. Brown et al., 1986; Conway & Bekerian, 1987a; Lancaster & Barsalou, 1997; Linton, 1986). Moreover, lifetime periods may themselves be thematically linked to form higher order themes such as work, relationships, and other themes (Conway, 1992; Linton, 1986). Indeed, there is some evidence that people form attitudes to periods from their life (e.g., *this was a time when things did not go well for me*) and this self-evaluative knowledge of a lifetime period may be represented at this level and be used in memory construction (cf. Bruhn, 1990). The temporal knowledge contained in lifetime periods may take the form of personal temporal schemas (Larsen & Conway, 1997; Larsen & Thompson, 1995; Thompson et al., 1996), which, at the very least, must delimit the boundaries of the period and also contain other knowledge of landmark events from which temporal order can be further inferred or constructed (see Shum, 1998; Skowronski, Betz, Thompson, & Shannon, 1991; and Thompson et al., 1996, for further discussion of this).

General Events

General events are more specific and at the same time more heterogeneous than lifetime periods. Barsalou (1988) found that general events encompassed both repeated events (e.g., *evening hikes to meadows*) and single events (e.g., *my trip to Paris*). Robinson (1992) pointed out that general events may also represent sets of associated events and so encompass a series of memories linked together by a theme. For example, Robinson (1992) studied what he called "mini-histories" for activities such as *learning to drive a car* and *first romantic relationship.* Initial findings suggested that these were organized around individual memories representing events featuring goal-attainment knowledge (both positive and negative) that appeared to convey significant information for the self (e.g., about how easily a skill was acquired and about success and failure in intimate interpersonal relations). Interestingly, both types of minihistory featured highly vivid memories for critical moments of goal attainment. Virtually all of Robinson's (1992) participants had vivid memories for the first time they drove a car alone and for a first kiss. Indeed, Robinson proposed that these first-time memories were a particularly important category of general event and served to determine the nature of the self. Similar suggestions have been made by Singer and Salovey (1993) in their study of "self-defining" memories, and we consider their work in detail in a later section. Robinson's findings suggest then that there may be local organization within the overall class of general events such that small groups of memories that are thematically related and that refer to a relatively proscribed period of time form a distinct knowledge structure at this level in the autobiographical knowledge base. Obviously, other types of events may also lead to local organization, for example, a holiday, a

[1] These terms were developed by Conway (1992, 1996b) and encompass similar terms used by other authors.

period performing some particular piece of work, a period of illness, and so on. N. R. Brown and Schopflocher (1998) demonstrated how when one memory is used to cue recall of a second, then striking event clusters emerge, and this suggests quite extensive local temporal organization of general events. Although knowledge at this level of specificity in the autobiographical knowledge base has yet to be thoroughly investigated, one prominent feature of general event clusters already identified is that they feature vivid memories of events relating to the attainment or failure to attain personal goals (Conway, 1992; Robinson, 1992).

Event-Specific Knowledge

The centrality of imagery to autobiographical memory has been noted by many researchers, from the original studies of Galton (1883; see Conway, 1990a, for a review) to Brewer's (1986) theoretical analysis of the predominant role of imagery in autobiographical remembering (see also Brewer, 1996, for a historical review). Indeed, in recent research imagery has been found to be a general predictor of memory specificity (J. M. G. Williams, Healy, & Ellis, 1999), whereas in the more specialized study of flashbulb memories (R. Brown & Kulik, 1977; see Conway, 1995, for a review of this area), recall of ESK is taken as a defining feature of memory vividness. In the most extreme form of flashbulb memories that occur following the experience of trauma, the intrusive recollection of highly specific single details is taken as a symptom of the clinical illness of PTSD (American Psychiatric Association, 1987). In recent studies it has been suggested that intrusive memories in PTSD, especially following a single traumatic experience, initially take the form of an unrelated set of sensory–perceptual details that only over time come to be associated with more abstract general event and lifetime period knowledge (Ehlers & Steil, 1995; van der Kolk & Fisler, 1995; but see Howe, 1997). This unorganized representation of ESK contrasts with the organization of event details typical of everyday, nontraumatic memories. S. J. Anderson and Conway (1993) found that the event details that make up a single specific memory could be accessed in either of two ways: (a) In one form of access, a distinctive or thematic detail was recalled first, and other details were accessed subsequently; (b) in another form of access, knowledge was accessed sequentially from details of first-occurring activities to last (see also Burt, Mitchell, Raggatt, Jones, & Cowan, 1995). In both cases, however, after initial access additional memory details were accessed in forward temporal order, suggesting that this was how these representations were organized in long-term memory. In other studies (S. J. Anderson, 1993) participants were asked to exhaustively recall details from their memories. For example, a participant who listed an activity such as *talking to Z* as a detail of a memory would be asked to recall this conversation. Overall, participants were able to do this for approximately 30% of the details listed to several memories, but there was very marked variation, and some memories led to the recall of many additional ESK details, whereas for others few or no additional details were available. This variability is what might be expected because it has been shown that ESK links to general event structures are fairly rapidly lost (within one week of encoding) unless these links are rehearsed (Burt, Kemp, Grady, & Conway, 2000; Burt, Watt, Mitchell, & Conway, 1998). As recall rates will differ for different memories, it follows that some memories will preserve more links to ESK than others. Nevertheless, when additional knowledge was accessed in the S. J. Anderson (1993) study it was virtually always in the form of visual images. These images did not appear to be recalled in any particular order, but rather, according to the participants, they simply "popped" into mind. This latter finding suggests that ESK is not subject to detailed prestored organization and instead comes to mind in response to internally elaborated cues that by the process of encoding specificity (Tulving & Thomson, 1973) make contact with the ESK; see below for further discussion of this point (cf. Conway, 1992, 1996b; Conway, Pleydell-Pearce, & Whitecross, 1999; Conway, Turk, et al., 1999).

A number of other studies have also demonstrated the centrality of ESK to autobiographical remembering more generally. For example, Johnson, Foley, Suengas, and Raye (1988) found that sensory–perceptual knowledge was the key feature that distinguished memory for experienced events from memory for imagined events. Conway, Collins, Gathercole, and Anderson (1996) found recall of ESK to be associated with both the correct and incorrect recognition of previously experienced events, further suggesting that ESK and the imagery to which it gives rise are critical in leading a rememberer to believe the truth of his or her memories. As Conway et al. (1996) pointed out, however, this may not be as dysfunctional a strategy as it may first seem: Brewer (1988) observed that the more sensory detail available at recall, the more accurate an autobiographical memory was likely to be, and, in general, Conway et al. (1996) found recall of ESK to be very strongly associated with correct recognition. Thus, in most instances the more ESK, the more likely that a recalled event has actually been experienced, although in exceptional circumstances presence of ESK can mislead a rememberer into erroneous and even false memories (Conway, 1997a; Conway et al., 1996). That ESK can take the form of the recall of "minutiae" (R. Brown & Kulik, 1977; Heuer & Reisberg, 1990) in even low-emotion memories was further demonstrated by B. H. Ross (1984), who found that people learning to use a word processor over a number of training sessions were often reminded of the exact words they had edited in a previous session. B. H. Ross (Blessing & Ross, 1996; B. H. Ross, Perkins, & Tenpenny, 1990) further proposed that such "remindings" (Schank, 1982, 1986) provide critical support for category learning and the creation of generalizations. Although not considered explicitly by B. H. Ross, an implication that can be drawn from these suggestions is that autobiographical memories may provide a basis for generalizations about the self and others.

From the present perspective it is of especial interest that in many cases of retrograde amnesia following brain damage it appears that access to ESK may be abolished, whereas access to at least some lifetime period knowledge and general events remains intact (reviews of this area can be found in Conway & Fthenaki, 2000; see too Nadel & Moscovitch, 1997). For example, investigations of several patients (e.g., Cermak & O'Connor, 1983; Stuss & Benson, 1986; Tulving, Schacter, McLachlan, & Moscovitch, 1988) with very dense focal retrograde amnesias (Kapur, 1993) and widespread brain damage encompassing frontal, temporal, and limbic regions found an inability to retrieve specific memories, whereas access to knowledge of lifetime periods and general events from the period covered by their amnesias remained intact. An unusual case of this is Cermak and O'Connor's (1983) patient S. S., who spontaneously provided what initially appeared to be

descriptions of memories but which on further investigation turned out to be well-established stories or narratives that the patient was in the habit of relating during social conversations. Thus, when his memory was tested more formally, S. S. proved unable to recall virtually any specific memories, but nevertheless he had good retention of his "stories" and in addition retained knowledge of lifetime periods and general events. Other patients in this group retained only fragmentary access to lifetime period and general event knowledge with fairly complete focal retrograde amnesias for specific memories. As these patients also had very dense anterograde amnesias it seems unlikely that they could have relearned this knowledge following their brain injury, although this possibility cannot be ruled out for patients with less extensive injuries (cf. Hunkin et al., 1995). More recently a series of patients have been reported who have marked damage to regions of the occipital lobes (Hunkin et al., 1995; O'Connor, Butters, Miliotis, Eslinger, & Cermak, 1992; Ogden, 1993). These patients typically cannot retrieve memories from the premorbid period prior to their injury but often have, in comparison, fairly intact memories for events in the postmorbid period, although these are less detailed and vivid than the memories of non-brain-damaged controls (Hunkin et al., 1995). One common feature of these patients is an inability, or strikingly reduced ability, to generate visual images of events experienced prior to their brain injury. For example, Ogden's (1993) patient could recall virtually no memories from his premorbid period, and those few he could recall were typically dominated by nonvisual ESK such as sounds (particularly music), smells, or movements. Nevertheless, this patient, like the patients of Hunkin et al. (1995) and O'Connor et al. (1992), appeared to have good access to lifetime period and some general event knowledge.

Summary: The Autobiographical Knowledge Base

Three broad areas of autobiographical knowledge have been identified: lifetime periods, general events, and ESK. Knowledge held at these different levels of specificity may be further organized into autobiographical memory knowledge structures (Barsalou, 1988; Conway & Bekerian, 1987a; Lancaster & Barsalou, 1997; Linton, 1986). Knowledge stored at the level of a lifetime period provides cues that can be used to index a proscribed set of general events and knowledge at the level of general events indexes ESK. Figure 1 illustrates this hierarchical scheme for a fictitious set of autobiographical knowledge based on protocols collected in our laboratory. Following Barsalou (1988), we view one major form of organization in the knowledge base as that of partonomic hierarchical autobiographical memory knowledge structures. In these structures items of ESK are part of general events that in turn are part of lifetime periods. A specific autobiographical memory is a stable pattern of activation over the indexes of these knowledge structures. The construction of patterns (memories) is constrained by the indexes, that is, by what other regions of the knowledge base a cue can access, and by central control processes that coordinate access to the knowledge base and modulate output from it (Conway, 1996b), and it is to an account of these that we turn next.

Part 2: The Self and Autobiographical Memory

Nearly all researchers in this area consider there to be an important and strong relation between the self and autobiographical memory. Brewer (1986), for example, argued that the inherent self-referring nature of autobiographical memories was a defining feature that distinguished these memories from all other types of long-term knowledge. Robinson (1986) proposed that autobiographical memories were a "resource" of the self that could be used to sustain or change aspects of the self. Indeed, memories have been found to be closely related to aspects of personality (McAdams, 1982, 1985; McAdams et al., 1997; Woike, 1995; Woike, Gershkovich, Piorkowski, & Polo, 1999), trait information (Klein, Cosmides, Tooby, & Chance, 1999), patterns of adult attachment (Bakermans-Kranenburg & IJzendoorn, 1993; Mikulincer, 1998; they also play a major role in the Adult Attachment Interview [AAI], the main method for exploring adult attachment styles; see IJzendoorn, 1995, and Steele & Steele, 1998, for reviews), and goal change and emotions (Stein, Wade, & Liwag, 1999). Also, memories are closely associated with aspects of self-schemas, which they may validate and support (Habermas & Bluck, in press; Markus, 1977). Relatedly, Singer and Salovey (1993) outlined what they termed "self-defining" memories and then investigated how these were critical to an individual's current goals and psychological well-being. The role of memories in providing a stable self-system (Beike & Landoll, in press; Conway & Rubin, 1993; Conway & Tacchi, 1996; Fitzgerald, 1988, 1996) and in contributing to specific aspects of the self such as generation identity (Conway, 1997a; Conway & Haque, 1999) have also featured in several recent investigations focused on development of the self in adolescence (Habermas & Bluck, in press; Holmes & Conway, 1999). With reference to earlier developmental stages, Howe and Courage (1997) proposed that it is only with the emergence of a structured self-system, at about 24 months, that children develop the ability to encode knowledge that can later form autobiographical memories (but see Fivush & Reese, 1992; Harley & Reese, 1999; Howe & O'Sullivan, 1997; Hudson, 1990; K. Nelson, 1993). Yet other authors have given similar priority to the connection between the self and memory but emphasized more negative aspects of this relation such as the distortion and even wholesale fabrication of memory in favor of current self-beliefs (Barclay, 1996; Barclay & Wellman, 1986; Conway et al., 1996; Conway & Tacchi, 1996; Greenwald, 1980; Mullen, 1994; Ramachandran, 1995; M. Ross, 1989; Solms, 1995, 1999; see Hastorf & Cantril, 1952, for a wonderful early example of just how powerfully the self influences encoding, recall, and perception of, in this case, a football game). In contrast, Skowronski et al. (1991) and Betz and Skowronski (1997) found that autobiographical memories for events high in self-reference were dated more accurately than memories for events of less self-relevance (see Larsen & Conway, 1997, for similar findings). In short, there appears to be a consensus that autobiographical memory and the self are very closely related, even, according to some theorists, *intrinsically related* so that autobiographical memory is a part the self (Conway & Tacchi, 1996; Howe & Courage, 1997; Robinson, 1986). By the view to be developed here, the self, and especially the current goals of the self, function as control processes that modulate the construction of memories. Recent approaches to the self suggest ways in which this relation between autobiographical knowledge

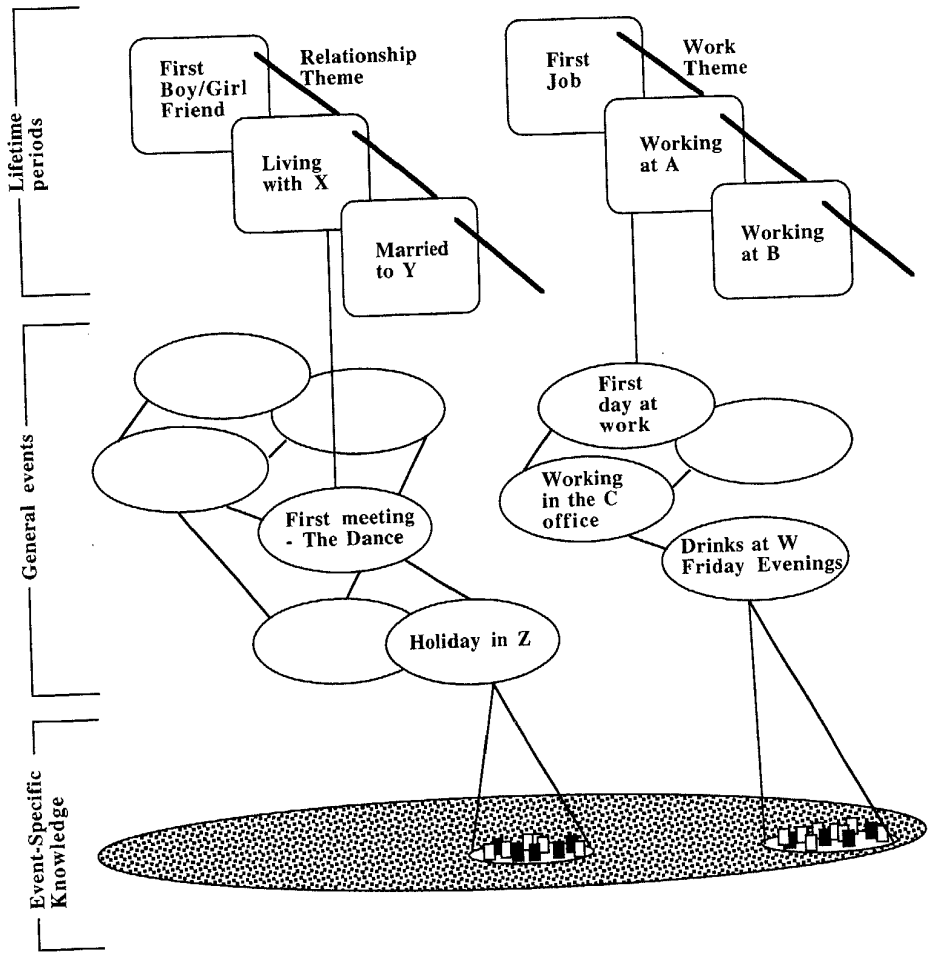

Figure 1. The autobiographical memory knowledge base. Note that event-specific knowledge (ESK) is shown as an undifferentiated pool of features, regions of which (the circles) are activated by cues held at the general event level. The small black and white squares indicate activated ESK. From "Autobiographical Memories and Autobiographical Knowledge," by M. A. Conway, 1996, in D. C. Rubin (Ed.), *Remembering Our Past: Studies in Autobiographical Memory* (p. 68), Cambridge, England: Cambridge University Press. Copyright 1996 by Cambridge University Press. Reprinted with permission.

and aspects of the self might be conceptualized, and in the following sections we draw on these as we sketch our view of the relations between memories and the self.

The Working Self

We introduce here the term *working self* to make an explicit connection to the concept of working memory as outlined by Baddeley (1986) and specifically to the notion that a core part of working memory is a set of control processes that coordinate and modulate other computationally separate systems (Baddeley, 1986; Burgess & Shallice, 1996; Moscovitch, 1992; Moscovitch & Umilta, 1991; Norman & Shallice, 1980; Shallice, 1988). According to this view the goals of the working self form a subset of working-memory control processes organized into interconnected goal hierarchies that function to constrain cognition, and ultimately behavior, into effective ways of operating on the world. We further conceive of the overall goal structure of the working self, at any given time, as a mental model of the abstract capacities and functions of the system (K. Craik, 1943; Johnson-Laird, 1983), as well as of state(s) desired by the individual[2] (see too Kahneman &

[2] We do this while at the same time recognizing that beliefs and attitudes are also significant aspects of the self but aspects that we only touch on in this article despite the fact that these too will play an important part in understanding autobiographical memory. Our view is that currently there is insufficient research to develop these domains, in terms of autobiographical memory, further at this point (but see Klein, Cosmides, Tooby, & Chance, 1999, for an important discussion of the potential relation of autobiographical memories to different types of personality trait judgments).

Miller, 1986). Additionally, we also use the term "working self" to make evident our reliance on highly similar views developed by Markus and Ruvolo (1989) and the related views of others (Cantor & Kihlstrom, 1985a, 1985b; Emmons, 1986; Little, 1983; McAdams, 1993; McGregor & Little, 1998; Schank, 1982; Schank & Abelson, 1977; Singer & Salovey, 1993). Markus and Ruvolo (1989) proposed that there is a set of self-schemas—core and peripheral long-term memory representations of different conceptions of the self (Markus, 1977)—and at any given time, some subset of these self-schemas are active and modulate cognition and behavior. Self-schemas, when activated, generate "possible selves," that is, selves, either feared or desired, that an individual might become (Markus & Nurius, 1986). Possible selves form what Markus and Ruvolo termed the "working self-concept," which is a constantly changing dynamic on-line conception of the self and what it may become. Stability here comes from the long-term memory self-schemas themselves, which represent different configurations of the working self-concept in different experiences. Although closely related to Markus and Ruvolo's working self-concept, our view is that the goals of the working self are constrained or grounded in autobiographical memory. The autobiographical knowledge base limits the range and types of goals that a healthy individual can realistically hold, and we return to this important point in the next section.

According to our view autobiographical knowledge is encoded through the goal structure of the working self, which also takes a major role in the construction of specific memories during remembering. Thus, the nature of working-self goals and how they emerge are important considerations for us, and although these issues lie outside the range of the present article, we consider those approaches focused on the control of self-discrepancies to provide a useful account of the emergence and nature of what we term "working-self goals" (e.g., Carver & Scheier, 1990; Higgins, 1987). In Higgins's (1987) theory, the self is separated into three major domains: the actual self (some approximately accurate representation of one's self, perhaps, even the system's mental model of itself), the ideal self (what the self aspires to), and the ought self (the self one should be as specified by one's parents, educators, other significant persons, and society generally). Discrepancies among the three domains lead to characteristic forms of negative emotional experience and, importantly for the present discussion, self-discrepancies have developmental histories. They originate from experiences in childhood, and memories of these critical experiences are often well retained and are accessible especially when cued by information relevant to the discrepancies held by an individual (Strauman, 1990, 1996). Self-discrepancies as described and investigated by Higgins (1987, 1996) provide the type of psychological tension capable of driving a dynamic system. For instance, self-discrepancies could determine the setting of personal goals and generation of plans to attain those goals. The overriding aim of such personal (working self) goals and plans would be the reduction of discrepancies among the three main domains of the self.

Goals and plans that function to reduce discrepancies can be conceived of as negative feedback loops that in their simplest form contain an input, a standard or comparator, and an output (Carver & Scheier, 1982, 1990; see Austin & Vancouver, 1996, for recent review of goal-based theories). States of the world are represented by the input and compared by the comparator to a standard. On the basis of this computation the output is adjusted, in some way, in order to reduce the discrepancy between input and standard to an acceptable value. Carver and Scheier (1982) described how the negative feedback loop in biological systems invariably takes a hierarchical form with a complex superordinate and subordinate goal structure. Other theorists (e.g., Oatley, 1992; Oatley & Johnson-Laird, 1987) show how complex hierarchical goal structures evolve to deal with multiple and competing goals, and how they may generate emotional experiences (see too Carver & Scheier, 1990; Ortony, Clore, & Collins, 1988; Stein & Levine, 1999). More generally our view is closely related to motivational theories of the self (Deci & Ryan, 1991; Dweck, 1991; Emmons, 1986; Little, 1983; D. C. McClelland, Koestner, & Weinberger, 1989; see Gaertner, Sedikides, & Graetz, 1999, for recent formulations) and especially those that emphasize goal coherence (Sheldon & Elliot, 1999) and regulatory functions in goal attainment (e.g., Gollwitzer & Brandstatter, 1997). Indeed, very vivid memories often arise in response to experiences in which the self and goals were highly integrated (e.g., experiences of goal attainment or progress toward attainment) or strikingly disjunct (e.g., experiences of goal irrelevance and plan failure; see below, and see Conway, 1995; Pillemer, 1998; and Robinson, 1992). Related to this are recent findings from cognitive dissonance theory (Festinger, 1957) and self-verification theory (Swann & Read, 1981) exploring cognitive reactions to memories. For instance, Beike and Landoll (in press) found that recall of memories that were inconsistent or dissonant with a lifetime period caused strong cognitive reactions. Thus, recalling a specific experience of goal attainment from a period generally evaluated as one of goal frustration gave rise to, among other reactions, attempts at "justification" (i.e., the recalled event was an exception) and "outweighing" (i.e., recall of many other consonant events from the period such that the dissonant memory is outnumbered). Importantly, the extent to which individuals were able to effectively use appropriate cognitive reactions to deal with dissonant memories was positively related to their sense of well-being, suggesting that control of memory may have far-reaching implications for mental health. The point we wish to draw from this brief account of domains of the self, negative feedback systems, and motivation is that self-discrepancies may serve to generate the standards against which inputs (perception, experience) are evaluated in hierarchical negative feedback control systems. Our main contention in this section is that it is through this goal-based working-self system that memories are originally encoded and later constructed and reacted to during remembering.

Goals and Memory

We have suggested that the goal structure of the working self is critical in both the encoding and retrieval of autobiographical knowledge, and several other researchers have also suggested that autobiographical memories are primarily records of success or failure in goal attainment (e.g., Barsalou, 1988; Conway, 1992; Schank, 1982). There is now substantial evidence to show not only that memories are related to goals but that broad subgroups of similar goals may selectively raise the accessibility of groups of goal-related memories. This work has its origin in a seminal article by Markus (1977), who found that people with a marked self-schema relating to the dependent–independent dimension showed

preferential access to memories of experiences in which they had behaved in dependent or independent ways. In contrast, individuals in whom the dependent–independent schema was not especially marked did not have this memory bias. These types of self-memory effects have since been observed in several studies and most especially in the programmatic work of McAdams (1982, 1985; McAdams et al., 1997) into power, intimacy, and generativity. McAdams (1982), using the Thematic Apperception Test (TAT; Murray, 1938, 1943), which is considered to assess nonconscious aspects of personality (D. C. McClelland et al., 1989), categorized individuals into those with a strong intimacy motivation and those with a distinctive power motivation. Content analysis of subsequently free-recalled memories of "peak" and other experiences found that the intimacy motivation group recalled peak experiences with a preponderance of intimacy themes compared with individuals who scored lower on this motivation and who in turn showed no memory bias. Similarly, the power motivation group recalled peak experiences with strong themes of power and satisfaction. Interestingly, neither group showed biases in memories for more mundane, less emotional memories. These striking biases in memory availability by dominant motive type suggest that the goal structure of the working self makes highly available those aspects of the knowledge base that relate most directly to current goals. In more recent work McAdams et al. (1997) examined the influence of the Eriksonian notion of *generativity* (Erikson, 1963) on the life stories of middle-aged adults. Generativity refers to nurturing and caring for those things, products, and people that have the potential to outlast the self. Those individuals who were judged high in generativity, that is, who had a *commitment story,* were found to recall a preponderance of events highly related to aspects of generativity. In contrast, those participants who were not identified as holding a commitment story showed no such bias. Related to this, Conway and Holmes (2000) found, in content analysis of older adults' free recall of memories from each of seven decades from their life, that each decade was marked by a preponderance of memories related to the psychosocial theme relevant to that age. For example, the majority of memories recalled from the period 10 to 20 years related to themes of identity–identity confusion, and from the decade 20 to 30 years memories of experiences of intimacy–isolation predominated (Holmes & Conway, 1999).

Work by Woike and her colleagues has further established the connection between personality and memory (Woike, 1995; Woike et al., 1999). In the tradition of personality research deriving from Murray (1938) and D. C. McClelland (e.g., D. C. McClelland et al., 1989), Woike identified implicit and explicit motives in a group of participants who then recorded memorable events over a period of 60 days. According to D. C. McClelland et al., implicit motives are evident in preferences for certain types of affective experience such as "doing well" for achievement and "feeling close" for intimacy, whereas explicit motives are present in social values and aspects of the self that can be introspected. A corollary of this view is that affective experiences should give rise to memories associated with implicit motives. Explicit motives, on the other hand, should lead to memories of less affective, routine experiences more closely associated with self-description than with measures of implicit motives, that is, TAT performance. This was exactly Woike's finding in both a diary study and in a laboratory-based autobiographical memory retrieval implicit–explicit motive priming experiment. Woike et al. (1999) investigated groups of individuals classified as "agentic" (concerned with personal power, achievement, and independence) or as "communion" (concerned with relationships, interdependence, and others). Agentic personality types are considered to structure knowledge in terms of "differentiation" (the emphasis is on differences, separateness, and independence), whereas communal people, in contrast, structure knowledge in terms of "integration" (the emphasis is on similarity, congruity, and interdependence). Across a series of studies agentic types were found to consistently recall emotional memories of events that involved issues of agency (mastery, humiliation) with their content structured in terms of differentiation. Communal types recalled emotions and memories featuring others, often significant others, in acts of love and friendship, with the memory content structured in terms of integration. These findings clearly implicate the self in determining recall and lend further weight to the suggestion that the working self influences access to sets of goal-related memories.

In an intriguing study Pillemer, Picariello, Law, and Reichman (1996; see too Pillemer, 1998) investigated memory for specific educational episodes. The initial impetus for this work was the observation that autobiographies often contain accounts of highly specific events that were "turning points" (self-defining moments) for the individual and that usually involved the adoption of a superordinate life goal that then determined much of the individual's later activities. Pillemer et al. (1996) found that students and alumnae were frequently able to report, in detail, highly vivid memories of interactions with professors and other teachers who profoundly influenced their academic interests and, sometimes, the whole of their life. These were often events in which superordinate long-term goals were adopted by the individual, for example, to become a chemist, a writer, and so on. Such self-defining moments in which major long-term goals emerge were also studied by Csikszentmihalkyi and Beattie (1979) in their investigation of a group of individuals who had in common extremely deprived childhoods. Some of this group became exceptionally successful in adult life, whereas others although surviving their impoverished upbringing did not achieve high-status professional occupations. Csikszentmihalkyi and Beattie found that all the individuals they examined had what they termed "life themes." Life themes were developed in response to existential problems facing the individuals in their childhood, such as extreme poverty, social injustice, and so on. The critical determining factor for later occupational success was the conceptualization of the problem and its solution. For instance, individuals who conceptualized their existential problem as one of poverty and its solution as ensuring a constant supply of money tended not to attain high-status occupations. Indeed one of their sample who by thrift and careful investment had become a millionaire nevertheless continued as a blue-collar worker in the factory where he had always worked. Other individuals who generated a more abstract conceptualization of the existential problems of childhood, such as "poverty is the result of social injustice, therefore one must fight against social injustice," achieved professional occupations that provided the opportunity to implement, at least to some degree, solutions to their earlier universalist abstract conceptualization. All the individuals in the Csikszentmihalkyi and Beattie (1979) study were able to provide highly detailed and vivid memories of critical moments in the genesis and attainment of their solutions to the life problems they

had identified. Many of the memories were spontaneously produced and even corroborated by independent evidence to which the individual had access. These memories of conceptualizing goal-based solutions to existential problems clearly constitute vividly recalled self-defining moments for these individuals (see Conway, 1996b).

Singer and Salovey (1993) provided one of the main statements on the relation between goals and memories. A major finding in their study was that memories associated with feelings of happiness and pride were strongly linked with goal attainment and the smooth running of personal plans (see too Sheldon & Elliot, 1999). In contrast, memories associated with feelings of sadness and anger were linked to the progressive failure to achieve goals. Singer and Salovey (1993) proposed that each individual had a set of "self-defining" memories that contained critical knowledge of progress on the attainment of long-term goals (Cohen's childhood memory described earlier is an example of a self-defining memory). Goals such as attaining independence, intimacy, mastery, and so on may have been adopted as solutions to dominant self-discrepancies arising from childhood experiences. Related to this, Thorne (1995) found that the content of memories freely recalled across the life span by 20-year-olds conformed to what she called "developmental truths." Thus, memories from childhood very frequently referred to situations in which the child wanted help, approval, and love, usually from the parents, whereas memories from late adolescence and early adulthood referred to events in which the rememberer wanted reciprocal love, was assertive, or helped another.

Next consider what may constitute a fundamental approach to the relation between the goals of the self and memory accessibility. The adult attachment literature contains reports of the use of the AAI (George, Kaplan, & Main, 1985), which is a structured interview that probes adult recall of affective childhood experiences. Classification on the basis of the AAI shows between 70% and 80% agreement with classification based on same adults' performance when they were children in the Strange Situation (Ainsworth, Blehar, Waters, & Wall, 1978; see IJzendoorn, 1995, for a review of AAI research). This is especially interesting because of Bowlby's (1969/1982) concept of an *internal working model* (IWM) of attachment held by each individual and derived from the history of his or her attachment experiences. In fact, Bowlby considered individuals to hold several IWMs that acted to maintain a positive image of the parents by keeping from awareness negative aspects and keeping available for conscious reflection more positive aspects (cf. Steele & Steele, 1994). Clearly, such representations would form an important part of the self, and the (working self) goals they specify would influence the accessibility of autobiographical knowledge. In connection with this, Bakermans-Kranenburg and IJzendoorn (1993) found that people with anxious–ambivalent attachments (dismissing) styles who, in the AAI, typically show very impoverished autobiographical memory for negative affective childhood experiences were nonetheless able to respond more rapidly than secure individuals to questions that did not focus on affective experience. Moreover the dismissing individuals did not differ from the secure individuals when recalling positive aspects of their childhood. Those authors noted the parallel here with Myers, Brewin, and Power's (1992; see too P. J. Davis, 1987) finding that "repressors' " latencies for autobiographical memories of negative experiences are reliably slower than those of nonrepressors. Accessing negative information (from childhood) that might (re)activate a dysfunctional attachment working model may then be defended against by rendering the goal-incompatible knowledge difficult to access. Indeed, for those negative memories that can be recalled, it seems that the content is highly related to attachment style. Mikulincer (1998, Study 1) investigated the autobiographical memories of anger experiences in individuals with secure, anxious–ambivalent, and avoidant attachment styles. Individuals with secure styles recalled memories of anger experiences that revealed an ability for functional anger with the characteristics of a rational appraisal of the experience, lack of intense urges to punish the anger provoker, and no hostile attributions to the other. Anxious–avoidant individuals recalled memories of anger experiences characterized by intense anger, hostile attributions, negative expectations of others, lack of anger control, rumination over anger feelings, and spread of distress to other emotions (see too Mikulincer & Orbach, 1995). Avoidant individuals recalled memories the content of which suggested *dissociated anger* in which intense physiological signs of anger and hostile attributions were not consistent with self-reports of anger intensity. Moreover, these memories often included escapist fantasies and responses ostensibly intended to remove the angry feeling without confronting the original cause of the anger. Working models of attachment, evolved originally in infancy and childhood, may then influence the accessibility of goal-relevant knowledge in the knowledge base by either facilitating or attenuating access: For those individuals with insecure attachments, accessing attachment knowledge may have exacerbating or destabilizing effects, and, as a consequence, this knowledge is harder to access.

Taken together, the pattern of findings reviewed in this section indicates that knowledge concerning personal goals permeates autobiographical memory. The goals of the working self determine access to the knowledge base, and by our view this occurs in the generation of retrieval models used to guide the search process. Such models may facilitate access by setting constraints in a way that benefits the search–elaborate–evaluate retrieval cycle; that is, the constraints are not too severe and the sought-for information not likely to be destabilizing (for the working-self goal structure) when accessed. On the other hand, retrieval models may aim to attenuate or prevent access by setting constraints that the search processes cannot satisfy or by prohibiting the recall of destabilizing knowledge such as highly emotional materials or attachment memories, recall of which would increase self-discrepancies and reactivate dysfunctional attachment behavior and feelings. Related to this, we note that Thorne (1995) found that participants in her study were unaware of the personal goals their memories so clearly expressed, leading her to suggest that motives were automatically but nonconsciously encoded into long-term memory. Similarly, in the Singer studies too (e.g., Singer & Salovey, 1993) the participants were unaware that the purpose of collecting ratings of memories on goal dimensions was to investigate how progress with personal goals was related to emotional experience. In the AAI and in several other of the studies described in this section participants were unaware of the goals and motives underlying recall.

This lack of reflexiveness and insight into goal aspects of memories, or anosognosia for past goals, may arise because specific memories do not directly represent goals (in a form that is retrievable), but rather they represent the outcomes of plans gen-

erated to attain goals. For example, in Robinson's (1992) minihistories of memories for a first relationship and learning to drive a car, vivid and specific memories of a "first kiss" and "driving alone" may not have explicitly represented knowledge of attaining the goals of intimacy, mastery, and independence, although these could be inferred from the content of the memories. Relatedly, Cantor and Kihlstrom (1985a, 1985b) in their study of the "life tasks" confronting first-year college students making the transition from high school to college found these to center around issues of identity, intimacy, achievement, and power (Cantor, Brower, & Korn, 1984, as cited in Cantor & Kihlstrom, 1985a, 1985b). Overall life tasks were focused on the two broad themes of social and academic activities and how to prioritize and manage tasks within the two domains. Although in these abstract terms the life tasks appear general to all students at the level of the individual, specific tasks were highly idiosyncratic and reflected personal projects. Thus, Cantor and Kihlstrom (1985b, p. 25) commented that "one student considered living without family to involve learning to handle the stress of personal failure without 'dad's hugs,' whereas another concentrated on the practical side of independence—'managing money, doing laundry, eating well'." Thus, the level at which goals are conceptualized by an individual may influence the type of goal-related autobiographical knowledge that is retained in the knowledge base. Moreover, it seems to us that most people do not explicitly cognize their goals on a moment-by-moment basis in everyday life; rather they are enacting plans to achieve goals, and this too must influence what is retained by the self-memory system (SMS). What is retained is knowledge of experiences in which plans were executed, but the plans and their goals may not themselves be explicitly represented in the knowledge base or, following Thorne (1995), may not be represented in a form accessible to conscious recollection.

Emotions and Memories

A further general finding from the studies reviewed above is that memories in which knowledge of goals featured prominently also featured memory for emotional experience. This finding fits well with Carver and Scheier's (1990) model of the relationship between goal attainment–abandonment and emotions and also with Oatley's (1992) theory of the function of emotions in plan maintenance, repair, and change. In Carver and Scheier's (1990) model the working-self goal structure ("action-guidance system" in their terminology) is monitored by a second system. The purpose of this second system is to assess and modulate the rate at which the goal system reduces discrepancy. The second system is the emotion system, and positive emotions reflect an acceptable rate of discrepancy reduction, whereas negative emotions reflect an increasing failure to reduce discrepancies. A similar model was outlined by Oatley and Johnson-Laird (1987) and considerably elaborated by Oatley (1992; see too Frijda, 1986, and, for a recent model, Bagozzi, Baumgartner, & Pieters, 1998). In the Oatley/Johnson-Laird model, emotions are viewed as special forms of communication between modularized domains of the cognitive system (and also between individuals). According to this view goals and plans communicate with other processes and structures only by their output, and other parts of the cognitive system communicate with the goal only via its input, as in the negative feedback loop. Each goal and associated plan has with it a monitoring mechanism, the purpose of which is to gauge "when a substantial change of probability occurs of achieving an important goal or subgoal" (Oatley, 1992, p. 50; see Wegner, 1994, for a related and interesting account of the functioning of monitoring processes and goals). When a change in probability is detected the monitoring mechanism broadcasts an alert signal to the whole of the cognitive system that sets it in readiness to respond. By this "communicative" theory of affect it is the alert signals from the monitoring mechanisms that are experienced as emotions.

This type of dual-process goal-centered account of emotions has been recently further developed by Brewin, Dalgleish, and Joseph (1996) in an attempt to account for vivid and intrusive memories in PTSD. They proposed a dual-representation model of traumatic memories (see Renya & Brainerd, 1995, for a more general dual-representation model of long-term memory) according to which knowledge from two different memory systems is brought together when a memory is constructed. One of these systems delivers verbally accessible parts of a memory and the other affective aspects of the original situation that are not verbally accessible but which can be (re)experienced in the form of affect and vivid imagery at recall. By this view then, emotional and nonemotional features of an experience can be represented separately and recalled selectively. The suggestion is that in PTSD the nonverbal affect-laden part of the memory is frequently (nonconsciously) cued and, as a consequence, intrudes into everyday cognition. Interesting evidence for the notion of dual representation comes from a study by E. D. Ross, Homan, and Buck (1994) in which presurgery focal epileptic patients recalled autobiographical memories while undergoing the Wada Test (WT). In the WT, patients are administered an intercartoid injection of amobarbital that, depending on the cartoid artery used, anesthetizes the left or right cortical hemisphere. Prior to the WT, patients recalled and provided a description of an intense emotional experience from their past. During the right-sided WT, patients were cued to recall and describe the same memory again. Sometime after the WT, patients took part in a third and final recall. No differences were found between the first and third memory descriptions. However, 8 of 10 patients showed changes in emotional experience when recalling their memories during the WT. In some cases emotional events were now described with much the same detail but with no reference to emotions, even when prompted. For other patients emotional experience associated with the memory was recalled but this was either lower in intensity or positive in nature when previously it had been strongly negative. These findings suggest that the emotionality associated with a memory may be lateralized to networks in the right cortical hemisphere (see Fink et al., 1996, and see below). A possibility that arises here, as E. D. Ross et al. (1994) pointed out, is that regions in the left hemisphere may have the facility to inhibit or repress right-hemisphere affective details of memories or to prevent the representation of these *as emotional experiences* when a memory is constructed (as appears to have occurred with Schooler, Bendiksen, & Ambadar's, 1997, patients). This could be achieved through using language. That is to say that (emotional) details of memories could be verbally labeled, and the labels could be stored in left-hemisphere networks. At recall only the verbal labels are retrieved, and, consequently, no or little affect occurs.

Another major line of work on emotions, goals, and memories has been reported by Stein and her colleagues (e.g., Levine, Stein,

& Liwag, 1999; Stein & Levine, 1987, 1989, 1990, 1999; Stein & Liwag, 1997; Stein, Liwag, & Wade, 1995; Stein, Wade, & Liwag, 1999). In their model experience of an emotion always signals change in working-self goals that have been attained, blocked, or threatened, and this leads to appraisal and goal change. Critically, this also gives rise to the formation of a causal model of the emotional experience (Stein & Levine, 1989; Stein & Trabasso, 1992; Trabasso & Stein, 1994), and this knowledge would, in our scheme, for specific experiences, be represented at the general event level (N. L. Stein, personal communication, May 1999). Stein and Levine (1999) in a detailed review noted that infants are considered to develop goals and show preferences between goals by about 4 to 6 months, with a complex preverbal goal system in place by the age of 1 year. In their developmental studies starting with children 2.5 years of age, Stein and her group have been unable to find any extensive or important differences in adult and child understanding of the causes of emotional experiences—the 2.5-year-old already has a sound understanding of emotional causality that, by implication, must have developed preverbally. One corollary of this is that children and adults should have comparable memories for emotional experiences, and Levine et al. (1999) investigated this in a study in which parents recalled specific events when their child (age between 2.3 and 6.6 years) had been happy, sad, angry, or frightened. The parents' memory descriptions were then used to cue the children to recall the same events. Concordance scores between the children's and parents' recall were Happiness = .80, Sadness = .72, Fear = .49, and Anger = .22. Parents made direct references to the goals of the child in 97% of memories, and the children made reference in 77% of cases, and all the descriptions contained accounts of the causes of the emotions. Interestingly, discordant cases were frequently associated with the parent attributing different goals to the child during the emotional experience and to goal conflict between parent and child. Children often recalled feeling sad in situations that their parents had labeled them angry, and Levine et al. (1999) speculated that this editing of memories may have occurred because it was threatening (destabilizing for the working self) to the children to recall episodes in which they were angry with their parents. Another possibility is that the child felt sad as a consequence of his or her fury and subsequently recalls only the sadness, which now overshadows the anger. Thus, relabeling and overshadowing may be yet other ways in which the SMS defends working-self goals (which at this age may have been structured around the Eriksonian themes of autonomy vs. shame and doubt, and initiative vs. guilt and purpose) from memories of fury with a parent. It is notable, however, that even these discordant, edited memories preserve an essential truth of the event: namely that the child experienced a negative emotion while interacting with the parent.

An extreme case of the potentially damaging effects of recalling negative emotional memories has been described by Markowitsch, Thiel, Kessler, von Stockhausen, and Heiss (1997). Patient A. M. N. was a young man who discovered a fire in the basement of his house. He suffered no injury during this incident but rapidly developed a dense retrograde amnesia stretching back 6 years to when he had been 17 years old. It transpired that A. M. N. had a long-standing fear of fires and especially fires with smoke (exactly the type he encountered in his home). This fear was related to a traumatic memory from childhood in which he had witnessed, at close quarters, a person burning to death in a car accident. The fire in his home had triggered recall of the trauma and, Markowitsch et al. (1997) argued, led to a powerful stress response. Positron emission tomography (PET) established hypometabolism throughout the medial temporal lobes and associated areas of temporal cortex. The authors concluded that the stress response to the memory led to raised levels of glucocorticoids, which in turn led to neuronal degeneration due to overstimulation of cells in the medial temporal lobes. Traumatic memories may often have the effect of triggering a stress response that increases glucosteroid release, causing degenerative overstimulation of hippocampal and medial temporal lobe networks (Markowitsch, von Cramon, & Schuri, 1993; Sapolsky, 1996), and, indeed, hippocampal shrinkage has been found in soldiers with PTSD (Gurvits et al., 1996) and survivors of childhood abuse (Bremner, Krystal, Southwick, & Charney, 1995).

There are then good reasons for powerful means of controlling the generation of emotional memories in the SMS, and it is instructive to additionally note the evidence that emotional cues are generally among the least effective of cues in eliciting autobiographical memory retrieval in laboratory studies (Conway, 1990c; Conway & Bekerian, 1987a; Conway, Pleydell-Pearce, & Whitecross, 1999; Robinson, 1976). Moreover, it is also the case, over many different studies (see Conway, 1990a, for review), that people show a bias to spontaneously retrieve far more memories associated with mild positive affect than they do memories associated with either intense emotions (positive or negative) or mildly negative affect. It seems then that there is a general bias against retrieving memories of intense and negative emotional experiences. This general inhibition must be supplemented by other forms of defense against reinstating intense emotions because it can be overcome and emotional memories can be intentionally retrieved (e.g., Christianson & Loftus, 1987; Conway & Bekerian, 1987b). Of special interest here is a PET study by Markowitsch et al. (1997) with patient D. O., a middle-aged woman who had been repeatedly sexually abused as a child. When in a specific mood D. O. was able to produce colorful drawings of scenes of interactions with adults from her childhood. For some of these drawings D. O. consciously knew what they referred to, whereas for others she knew they referred to traumatic experiences but memories for a specific experience were not accessible. In the PET study regions of the right temporal pole were found to be most active in the condition in which D. O. experienced intense but diffuse emotions to pictures she knew referred to inaccessible autobiographical memories of childhood sexual abuse. This region is known to be important in the construction of autobiographical memories (see Conway & Fthenaki, 2000, for review). Therefore, one strong implication of these PET data is that the networks that mediate memory construction can also keep from consciousness destabilizing knowledge, which nonetheless was almost certainly activated when D. O. thought about those pictures the origins of which she was unaware.

Constructing memories of emotional goal-related experiences poses potential difficulties for the working self, especially as these memories induce intense states of autonoetic consciousness in which the past is mentally "relived" (Wheeler, Stuss, & Tulving, 1997). An important implication of this is that when autobiographical memories are constructed in the SMS they have a *potential* to reinstate the goals and emotions that featured in earlier experiences. For some, perhaps many, memories, this potential may be

weak and therefore of little consequence; for other memories where the potential for reinstatement of past goals and emotions is strong, then memory construction could have powerful disruptive effects. Thus, a fundamental problem for the SMS is that if intense emotions are (re)experienced in the working self then, potentially, the current operation of the whole cognitive system could be disrupted. Emotional memories, when they cause emotion at recall, disrupt the operation of the current goal structure by placing the cognitive system into a state of readiness for change. In effect, emotional memories could reinstate (past) signals for action. The power of memories for previous emotions to disrupt current processing tasks is then potentially very great and, as we have seen in extreme cases such as PTSD, can attain pathological levels. The available evidence indicates that the SMS has evolved in such a way as to minimize disruption but still maintain access to memories of intense emotional goal-related experiences. This later facility is important as these memories are records of experiences of significant plan change and, accordingly, contain valuable knowledge of how change was successfully or unsuccessfully negotiated in the past. The studies reviewed in this section suggest that there are various ways in which the working self protects against emotional memories, and all of these feature *selective* incorporation of knowledge into retrieval models. This is possible precisely because representation of experiences in long-term memory is distributed over several different processing systems with emotional aspects of an event (probably) stored separately from nonemotional aspects. Thus, working-self goal structures both facilitate and inhibit knowledge access and in this way construct autobiographical memories of emotional experiences in which the *reexperience* of previous affect either does not occur or is attenuated.

The Self-Memory System

The SMS refers to the conjunction of the working self with the autobiographical knowledge base, and it is conceived of as a superordinate and emergent system: (a) It is superordinate in the sense that its convergent parts, the working self and the knowledge base, when conjoined allow autobiographical remembering that could not otherwise occur (cf. Conway & Fthenaki, 2000), and (b) it is emergent in that it is only when the two components interact that they form a system—both can function independently (as detailed below). The relation of the working self to autobiographical knowledge is a reciprocal one, and the goal structure of the working self is constrained by its own history. Thus, Conway and Tacchi (1996) proposed that one of the general functions of autobiographical knowledge was to "ground" the self. The idea of this grounding is that goals cannot simply be adopted on demand or be unrealistic; instead they are embedded in the SMS with representation in the working self and archival connections in the knowledge base. By this view a person could not maintain a goal (or goal structure) that contradicted autobiographical knowledge, so, for example, the goal of becoming a parent could not be maintained if knowledge of one's children can be accessed. Similarly a past "possible self" of, for instance, outstanding achievements at school could not be realistically maintained (although it might be pathologically maintained) when a series of memories of academic underachievement can be recalled. The range or universe of goals that an individual can maintain is delimited by autobiographical knowledge that places consistency and plausibility constraints on what goals can be held by the working self. When the current goals and plans or possible selves of the working self are in opposition to autobiographical knowledge, then there has been a breakdown in the normal functioning of the SMS, and depending on severity the system may enter a pathological state.

Failure to resolve conflicts in the SMS, that is, incompatibilities between knowledge and goals, may underlie a range of disorders and can be strikingly observed in patients with neurological damage to the frontal lobes. In some cases frontal lobe patients confabulate plausible (or near-plausible) autobiographical memories and autobiographical facts that are untrue (cf. Baddeley & Wilson, 1986; Burgess & Shallice, 1996; Conway & Tacchi, 1996; Dalla Barba, 1993; Kopelman, Guinan, & Lewis, 1995; Moscovitch, 1995; Moscovitch & Mello, 1997; Talland, 1965). Conway and Tacchi (1996) proposed that this occurs because connections within the SMS, mediated by networks in the frontal cortex, have been disrupted by neurological damage. The reciprocal constraints between the working self and the autobiographical knowledge base weaken or become wholly ineffective and autobiographical knowledge can now be configured in ways that support ungrounded goals and plans. For example, the frontal patient O. P. studied by Conway and Tacchi (1996) confabulated and persistently maintained a set of plausible but false memories that rewrote the disappointments in familial interactions of her past into a history of successful and supportive intimacy with certain, significant, family members. Interestingly these confabulated memories were more vivid and detailed than other "true" memories that O. P. was able to retrieve. This type of motivated confabulation may be more common in frontal patients than previously thought as these patients actively attempt to understand and compensate for other disabilities that have arisen as a consequence of their brain damage (see Conway & Tacchi, 1996, for further discussion of this point and also Marshall, Halligan, & Wade, 1995). Other examples of this disruption to the grounding of the self in autobiographical knowledge can be found in clinical cases such as the schizophrenic patients studied by Baddeley, Thornton, Chua, and McKenna (1996). These delusional patients maintained a range of false beliefs. For instance, one young man claimed to be a professional rock guitarist but was nonplused when it was pointed out that he could not in reality play a guitar and countered with the point that a lot of rock guitarists simply acted playing guitar when appearing on television—which, of course, was his tactic too. Of the patients described by Baddeley et al. most appeared to hold goals and beliefs almost wholly unconstrained by autobiographical knowledge, which they very often directly contradicted (see Conway, 1997c; Conway & Fthenaki, 2000; Kopelman et al., 1995, for review).

Other types of deluded beliefs may have yet a different origin but still rest on a disjunction between memory and self. For instance, Ramachandran (1995) in a series of studies found that patients with right parietal lesions may deny their left-side paralysis (anosognosia) and confabulate about left-side limb movement. When given a particular physical treatment these patients' anosognosia is temporarily abolished, and they then correctly recognize not only that their left side is paralyzed but also for how long it has been paralyzed. As the effects of the treatment dissipate the anosognosia returns, and the patient once again denies and confabulates the paralysis. Interestingly, these patients continue to recall the event during which they were not anosognosic, but the

memory becomes distorted, and they recall only that there was nothing wrong with their arm. These patients may be extreme cases where the duress of having to acknowledge an unacceptable present leads to splits (between goals and knowledge) in the SMS and, ultimately, a confabulated self. Indeed, Solms (1995, 1999) argued that these patients are undergoing pathological mourning for a part of the body that has died but they cannot acknowledge this death, perhaps because of the extremity of the negative affect that would result. Solms (1999) reported that some limited psychoanalytic treatment can be useful in overcoming this type of denial.

Autobiographical knowledge can then constrain the goal structure of the working self, but it is also evident that the working self may determine what autobiographical knowledge can be accessed and how that is to be constructed into a memory. Autobiographical knowledge that is strikingly discrepant with the current goal structure might be actively prevented from influencing it (as, e.g., the studies of anosognosic neglect patients demonstrate), or, perhaps, when accessed the knowledge is edited, distorted, or changed in some other way, as Freud (1915/1957) originally postulated and as several recent commentators have further emphasized (see, e.g., papers in the volumes by Schacter, 1996, and Conway, 1997c, as well as Bowers & Farvolden, 1996). A current demonstration of this comes from a study by Schooler et al. (1997), who investigated a series of individuals who had recovered memories of childhood sexual abuse. Importantly both the amnesias for the abuse and the actual occurrence of the abuse were corroborated. Of especial interest is the observation that although these patients were amnesic for the incidents of abuse (i.e., they were unable to recall any detailed memories), they often knew they had been abused. One patient, for example, had apparently informed her exhusband that she had been sexually abused as a child, and this knowledge was imparted in a nonemotional and brief manner. Later when this patient recovered memories of the abuse she was astonished to discover that her exhusband knew of it and that she had informed him—this came to light during Schooler et al.'s (1997) attempts to corroborate the amnesia and abuse. Admittedly, these are extreme cases of the working self exercizing inhibitory control over the autobiographical knowledge base; nevertheless, all of the evidence reviewed earlier on goals and emotions leads to the conclusion that the working self routinely gates access to knowledge and this can be either inhibitory or facilitatory.

Finally, before closing this section it will be useful to briefly consider more general aspects of the proposed SMS and its relation to other putative memory systems. We consider the SMS to be a superordinate memory system that coordinates access to and output from several other more subordinate memory systems. For example, the selection and elaboration of cues that iteratively access the autobiographical memory knowledge base is a function of the SMS (at least in generative retrieval; see below). Similarly, the SMS determines, largely on the basis of goal compatibility, what (accessed) knowledge will or will not be combined into an autobiographical memory. Thus, the SMS is fundamentally concerned with the combination of accessed knowledge into a stable representation that, preferably, is not excessively incompatible with current goals: The SMS arranges prestored knowledge (by successively elaborating cues) into a form in which it can be experienced as a memory or recognized as part of the personal past. Two factors that facilitate this basic "organizing" role are (a) the structure of autobiographical knowledge and (b) the goals of the working self. We discuss both of these at length in a later section.

An additional point relates to the correspondence between the SMS and forms of knowledge postulated by other theorists, for example, semantic, episodic, and procedural memory (Tulving, 1985). There is nothing in our model of autobiographical memory knowledge that corresponds directly to Tulving's (1972, 1983, 1985) concept of episodic memory. However, the combination of ESK with general events does give a representation that is equivalent to the notion of episodic memory, but note that this combination is transitory; that is, it is something that takes place during an act of remembering and is not prestored. It might be that general events and lifetime periods could be regarded as types of personal semantic knowledge, but this implicitly introduces a distinction between personal and impersonal semantic knowledge. Whether much is to be gained by such a distinction is unclear. On the other hand, simply classifying general events and lifetime periods as semantic knowledge underplays the important role of both types of knowledge in autobiographical remembering. It seems to us that the distinctions we have made between different types of autobiographical knowledge do not fit well with concepts such as episodic and semantic memory. Instead, we consider there to be a general purpose, long-term memory knowledge base that includes all types of declarative knowledge (Cohen & Squire, 1980; Squire, 1992). Organization within this knowledge base may create single "regions" of similar types of knowledge that at their boundaries blur into other knowledge types; that is, general events may blur into generic memories and scripts (cf. Conway, 1990b). When structures in this knowledge base are activated *and* this leads to the activation of ESK then remembering takes place. Our notion of ESK, on the other hand, may have features in common with conceptions of procedural–presemantic memory. We have argued (Conway, 1992, 1996b) that ESK is a summary record of sensory–perceptual processing occurring during an experience. Information in this representation is rapidly lost unless it becomes linked to a general event or, in special circumstances, has a privileged association with goals. ESK is prestored in posterior neocortical networks and, if accessed, can influence cognition (a) indirectly, by priming; (b) directly, by combining with more abstract personal knowledge in the formation of a memory; and, ultimately, (c) by being recollectively experienced (Conway & Fthenaki, 2000).

Our conception of the dynamic generation of autobiographical memories from the SMS is, however, highly compatible with the view of episodic memory recently and independently developed by Wheeler et al. (1997; and Wheeler, 2000). According to this account a critical component of episodic remembering is the ability to have "autonoetic" conscious or to recollectively experience the past. Autonoetic consciousness is associated with imagery, a sense of the self in the past, and type of mental reliving of an experience. Most importantly this type of remembering occurs when the system is in retrieval mode and, so it is suggested, involves a dynamic interaction of networks located in the frontal lobes with more posterior-placed networks. In our account of autobiographical remembering, ESK is the knowledge type most strongly associated with imagery and a sense of pastness (cf. Conway, 1992, 1996b, in press), and, possibly, it is ESK that induces or triggers autonoetic consciousness. This, however, would have to take place in the SMS when the working self is

fused with the knowledge base, a view highly compatible with those of Wheeler et al. (1997). Thus, the present model is not overly compatible with previous conceptions of episodic memory but does converge with several aspects of more recent developments of this concept; in particular the concepts of retrieval mode and autonoetic consciousness are closely related to our postulated emergent memory system: the SMS.

Part 3: The Construction of Memories

We have proposed that a specific autobiographical memory is a pattern of activation across the indexes of the autobiographical knowledge base conjoined with a subset of activated working-self goals. In our current terms, a memory is an interlocked pattern of activation across both components of the SMS. Patterns of activation that represent specific memories can be generated either by *generative retrieval* or by *direct retrieval* (Conway, 1992, 1996b; Moscovitch, 1989; Moscovitch & Mello, 1997). The main difference between the two types of retrieval is that the search process is modulated by control processes in generative retrieval but not, or not so extensively, in direct retrieval. We turn now to an account of each type of retrieval.

Generative Retrieval

The notion of generative retrieval derives from Norman and Bobrow's (1979) proposal that memory retrieval is mediated by "memory descriptions." Their view was that retrieval was an iterative three-stage process with the first stage entailing the elaboration of a cue with which to search memory and the simultaneous setting of verification criteria. The second stage involved matching the description to records in memory, and in the third stage records accessed in memory were assessed against the verification criteria. If the verification criteria were met then retrieval ceased and the accessed information could be output to other systems. If the verification criteria were not met then the whole three-stage process was cycled through again iteratively until the criteria were met. D. M. Williams and Hollan (1981) in a protocol study of students retrieving the names of former classmates found good evidence in favor of the three stages, and Whitten and Leonard (1981) in a study of former students recalling the names of their grade teachers also provided extensive evidence for the elaboration stage, strategic search stage, and evaluation stage. A more general point to make concerning the three-stage process (and this applies to the derivatives of the Norman and Bobrow model discussed below) is that it is essentially a discrepancy-reducing process and equivalent to a negative feedback loop. The input to retrieval is the elaborated cue, the standard is the verification criterion, and the output is whatever is accessed in long-term memory, *which then serves as input* to the retrieval loop. In Norman and Bobrow's (1979) model, the purpose of the generative retrieval cycle was to gain access to a "record" (e.g., of an experience or of some aspect of conceptual knowledge) that would reduce the discrepancy between knowledge currently activated and the verification criteria. Once accessed, the record was then fully available and could be evaluated against the criteria. Other models, such as that of Morton, Hammersley, and Bekerian (1985), have elaborated on this staged-retrieval-of-records view.

Although, as we show below, the proposal of a staged and controlled retrieval process has been fairly widely accepted by autobiographical memory researchers, the suggestion that the purpose of this process is to access a record has not received such widespread support. A fundamental problem with the records view is that it has difficulty in accounting for phenomena such as confabulation (Burgess & Shallice, 1996; Conway, 1990a, 1992, 1996b) and more generally for other types of false memories (e.g., Conway, 1997a; Conway et al., 1996). Additional problems are that the records view cannot provide a compelling account as to why autobiographical memory retrieval should typically take up to five to six times as long as the verification of semantic facts (Conway, 1992), or why access to more abstract autobiographical knowledge should be preserved in some cases of focal retrograde amnesia when access to specific autobiographical knowledge is lost (but see Morton et al., 1985). The memories-as-records approach is also silent on the whole issue of goals and the relation of autobiographical memories to the self. For these reasons the records aspect of the Norman and Bobrow (1979) model has not been adopted by other researchers (with the exception of Morton et al., 1985), and instead a component or features approach has been the choice of most researchers (Barsalou, 1988; Burgess & Shallice, 1996; Conway, 1990a, 1992, 1996b; Conway & Rubin, 1993; Howe & Courage, 1997; see too N. R. Brown et al., 1986; Conway & Bekerian, 1987a; Linton, 1986; Schooler & Herrmann, 1992; Treadway et al., 1992). In its most abstract form, the component approach views memories as patterns of activation over units that represent components or features of events. Combining this representational scheme with the staged retrieval model provides a powerful way in which to model the construction of autobiographical memories.

Two current views of generative retrieval have been put forward by Conway (1996b) and Burgess and Shallice (1996); as the two views differ only marginally we will provide a synthetic account drawing equally from both. The main developments of the original Norman and Bobrow (1979) model have been in linking the elaboration and verification stages to central control processes, and both Conway (1996b) and Burgess and Shallice (1996) proposed that these stages are modulated by supervisory executive processes most probably sited in networks in frontal cortex. A crucial component identified here is an analysis of task demands, and it is the resulting mental model of what these demands are that forms the criteria against which accessed knowledge will be evaluated. Verification criteria will vary with the task demands, and the types of memories constructed will be determined by different sets of criteria on different occasions. For example, constructing memories in order to make strategic self-disclosures in a social interaction, recalling memories with intimate others, ruminating over the past, and even recalling specific memories at the request of an experimenter entail the generation of criteria that fit the goals of the self in each context. The criteria that evolve may have facilitative effects so that when any knowledge accessed in the knowledge base corresponds within some preset tolerance to the criteria then that knowledge immediately enters into current control-processing sequences. Verification criteria may, on the other hand and as we have seen, have a very different purpose, namely the inhibition of irrelevant knowledge and inhibition of access to knowledge that is prohibited by self-goals (i.e., knowledge that would result in unacceptable increases in self-discrepancies). In

addition to goal-derived verification criteria there are also general criteria, perhaps acquired through socialization experiences, as to what mental states can be accepted by the rememberer as a memory (Conway, 1996b; Conway et al., 1996; Conway & Tacchi, 1996). For instance, an individual may require the generation of images of sensory–perceptual properties of the target event; possibly rememberers have some knowledge of features of autonoetic consciousness (Tulving, 1985) such as a sense or feeling of the self in the past and require these to occur if a mental state is to be accepted as a memory. Finally, there may be external specifications that set criteria, as occurs in the laboratory when an experimenter requires retrieval of a memory of a highly specific event, as also occurs in many everyday settings such as recalling with others details of a shared experience, providing eyewitness accounts, or recalling decisions made at a recent meeting, and so on. Criteria from all these different sources are bound together in a mental model that will serve as the *retrieval model* for the memory. Note that for frequently constructed memories the retrieval model used in construction may itself be eventually represented in long-term memory (Barsalou, 1988; Kahneman & Miller, 1986). When this occurs, accessing the prestored mental model may facilitate memory construction and lead to rapid retrieval.

In the cue-elaboration phase the earlier models assumed that a cue (usually externally presented) accessed a record, and then (when the sought-for knowledge was not immediately accessed) the original cue and first-accessed record were used to generate a second cue and initiate a further search of long-term knowledge. It now seems that, at least in the case of the construction of autobiographical memories, the initiation and iterative process of cue elaboration is more complex than previously thought. From our own protocol studies of memory retrieval (Conway, 1996b, Conway & Haque, 2000), it has become apparent that rememberers have fast access to lifetime period and general event knowledge (see too Burgess & Shallice, 1996). Thus, when presented with a cue to which a memory must be retrieved and required to report "anything that goes through your mind," the first thoughts in the initial few seconds of retrieval are virtually always of general autobiographical knowledge. Interestingly, although lifetime period knowledge is often evident at this point in retrieval, knowledge of general events is frequently more dominant (Burgess & Shallice, 1996; Conway & Haque, 1999). Conway (1996b) suggested that this may be because general events are the preferred level of entry into the knowledge base, particularly when the whole system is in retrieval mode (Schacter et al., 1998; Tulving, 1983) and a conscious willed attempt is made to recall a specific event. The implication of this is that the SMS has some sort of model of itself that can be used to elaborate a cue (the model of the system or the actual self). The partonomic hierarchical layering of autobiographical knowledge may deliver this model in the form of a summary of abstract knowledge of the knowledge base that is readily available to control processes. It may be that this more abstract autobiographical knowledge is closely linked to the working-self goal structure (perhaps it too is represented in frontal networks; see Conway & Fthenaki, 2000, for neuropsychological evidence that this probably is the case) and through this association becomes rapidly available in the first stage of cue elaboration (see Burgess & Shallice, 1996, for an extended discussion of the types of knowledge drawn on in memory construction).

Both Conway (1992, 1996b) and Burgess and Shallice (1996) viewed the search stage as independent of control processes and as taking place in associative networks of knowledge (the autobiographical memory knowledge base) distributed over several different memory systems (Damasio, 1989; Schacter & Tulving, 1994; Tulving & Schacter, 1990). By this view the elaborated cue or memory description activates pathways through the knowledge base, and this activation is channeled by the indexes of the knowledge structures. As knowledge is activated it becomes available to control processes and to the retrieval model where it is continuously evaluated. By rapidly generating new memory descriptions and entering these into the knowledge base, a pattern of activation can be shaped that meets the criteria of the retrieval model. As soon as this pattern of activation is established, a memory has been constructed. Thus, a specific autobiographical memory is a pattern of activation across the indexes of the autobiographical memory knowledge base conjoined with the retrieval model used to shape that pattern. The pattern of activation once established almost immediately begins to dissipate and must be effortfully maintained if it is to persist: Like an image (not least because most memories contain images), it must be constantly refreshed (Kosslyn, 1980) or parts will return to their resting state, or even fall below threshold, in which case the pattern required by the retrieval model will no longer be instantiated and no specific memory will be present.

Direct Retrieval

A key feature of the autobiographical memory knowledge base is that it is responsive to cues of all types at all levels of abstraction from the highly specific—for example, a taste (Proust, 1913/1981) or an odor (Rubin, Groth, & Goldsmith, 1984)—to the abstract structure of a problem (B. H. Ross et al., 1990; Schank, 1982; see Conway, in press, for review). Because of this we assume that patterns of activation continually arise and dissipate in the knowledge base, and on some occasions this may lead to the formation of a pattern that if linked to working-self goals would immediately form a memory. The formation of a distinct and stable pattern is quite probably infrequent and dependent on the specificity of the cue and how it is processed and, in particular, with the ability of the cue to directly activate ESK. Conway (1997c) discussed this in detail, but briefly: ESK representations have mappings to one general event (see Figure 1; there may be a few instances in which this is not the case), and general events have a *main* mapping to one lifetime period (they may have subsidiary mappings to other lifetime periods and will have many mappings to other associated general events). Activation spreading from an item of ESK activates a single general event that in turn activates a single lifetime period forming a focused and stable representation, and all that is then required is a linking of this pattern to the goal structure of the working self and a memory will be formed. Cues that when processed do not activate ESK (the majority of cues) must activate general events, lifetime periods, or both if they activate any autobiographical knowledge. But the spread of activation at these levels is diffuse. Knowledge held at the level of lifetime periods can access many different general events, and knowledge held in general events can access many associated general events, a lifetime period, and many records of ESK. In this case then, without the coordinating influence of a retrieval model in generative retrieval mode, a focused and stable pattern of activation will not

coalesce within autobiographical knowledge structures, and there is no potential for very rapid memory formation without additional processing.

When a stable pattern of activation emanating from ESK becomes established and then linked to working memory goals, a rememberer experiences spontaneous and unexpected recall of a memory. In terms of the moment-by-moment activation of the knowledge base, such occurrences are rare, but as an everyday experience spontaneous recall occurs fairly frequently. Berntsen (1996), for instance, found a rate of two to three memories spontaneously recalled each day. Many informal reports of spontaneous memory retrieval, often cited in works of literature, appear to frequently arise in response to specific cues of which the rememberer is (later) aware, and when spontaneous recall occurs it interrupts current activities (Salaman, 1970; see Conway, 1997c, in press, for a recent review). This disruptive effect of spontaneous retrieval is probably one of the main reasons why control processes have evolved to inhibit awareness of endogenous patterns of activation in the autobiographical knowledge base. Several theories have postulated central control over the outputs of long-term memory—most notably Norman and Shallice (1980), who described what they termed the Supervisory Attentional System, which contained a putative mechanism called the Contention Scheduler. The function of the Contention Scheduler was to control which currently active long-term memory schemas were to be linked into current processing sequences; that is, the Contention Scheduler synchronized long-term memory output with central processing sequences. In the case of autobiographical memory, however, if patterns of activation, perhaps multiple patterns, are constantly present it is not simply a question of controlling synchronization, but rather a judgment is required of whether any of the patterns should be linked to control processes of the SMS. Exactly how endogenous patterns of activation are selected remains unknown, but this must in part depend on how strongly (positively or negatively) they relate to currently active goals. Also unknown is how such potential memories are kept from awareness, although this may involve some sort of inhibitory control (cf. M. C. Anderson, Bjork, & Bjork, 1994; Bjork, 1989; MacLeod, 1997) and perhaps also depend on the central processing capacity (see Wegner, 1994). On this latter point reports of spontaneous recall often feature experiences in which the rememberer was in a stressed or distracted state (Conway, 1997a). Overall it seems that there must be some constant monitoring and constant inhibition of the knowledge base and that this is guided by working-self goals.

Summary: Generative and Direct Retrieval

In this section we have outlined current thinking on the staged construction of autobiographical memories of specific events as this takes place in the SMS. Two crucial presearch stages are the elaboration of a cue and the setting of a verification criterion in a retrieval model. Once initially established these two processes respond dynamically to knowledge activated in the autobiographical memory knowledge base by shaping successive elaborated cues in order to incrementally satisfy the constraints imposed by the verification model. Once the constraints imposed by the model are satisfied to some preset threshold, searches of the knowledge base cease and a memory is formed. This staged process of generative retrieval occurs in intentional attempts at recall when a rememberer is in retrieval mode (Nyberg, Tulving, Habib, Nilsson, & Kapur, 1995; Schacter, Alpert, Savage, Rauch, & Alpert, 1996; Schacter et al., 1998; Tulving, 1983). On other occasions focused and stable patterns of activation may arise in the autobiographical memory knowledge base as a consequence of activation of ESK. When this occurs there are several possible outcomes: (a) Activation in the knowledge base is prevented from entering into current processing sequences and, hence, awareness; (b) the endogenously generated pattern of activation is selected by control processes, it enters current processing sequences and awareness, and the rememberer experiences "spontaneous" recall; or (c) inhibitory processes that normally prevent endogenous patterns of activation of autobiographical knowledge from influencing the operation of executive control processes may be overcome and the SMS automatically put into retrieval mode as the pattern of activation becomes linked to working-self goals with the rememberer again experiencing spontaneous retrieval. But no cue elaboration and search phases take place in either of these three cases. Importantly, in direct retrieval the working self and its goals operate only *after* memory construction has taken place in the knowledge base.

Part 4: The Neuroanatomy of Autobiographical Remembering

If our theory is correct, then when a memory is generated to a cue the first neuroanatomical sign should be rising activation of networks in the frontal lobes (working self), followed by extensive activation of more posterior networks (possibly on the right side; Fink et al., 1996), culminating in the formation of a stable pattern of activation in posterior networks (the knowledge base). In order to evaluate this prediction of the model we recently conducted an electroencephalogram (EEG) followed by a PET study of autobiographical memory retrieval (Conway, Pleydell-Pearce, & Whitecross, 1999; Conway, Turk, et al., 1999). In the EEG study participants retrieved memories to cue words, and once a memory was retrieved participants were required to hold it in mind for a period of 5 s, after which they were cued to dismiss the memory from mind (also for 5 s) and prepare for the next trial. Throughout the duration of each trial direct current shifts were monitored, and the trial structure allowed the mapping of slow cortical potential (SCP) wave changes during memory retrieval (from cue presentation to response indicating that a memory was in mind), maintenance of a memory (the 5-s holding period), and inhibition of a memory (5-s preparation for the next trial). Thus, the pattern of changes in potentials at different electrode sites during the three phases of each trial showed the flow of activation through different cortical regions as a memory was retrieved, held in mind, and then inhibited. During the early phase of retrieval, after a cue had been read, anterior temporal and frontal regions became active in the left hemisphere. Also present at this point was some weaker activation of right frontal sites. In our view the pattern of left-hemisphere activity reflects the predicted role of central control processes in generating a retrieval model within the SMS. Indeed, other recent neuroimaging findings also indicate that highly self-relevant knowledge is processed by networks in the left frontal lobes (Conway, Turk, et al., 1999; F. I. M. Craik et al., 1998; Maguire & Mummery, 1999). The negativity detected in right frontal regions, on the other hand, may have reflected early attempts to access the autobiographical knowledge base.

At the point of memory retrieval, there was a growth of activation in bilateral posterior regions and in particular to regions of the posterior temporal lobes and occipital lobes, and this was especially marked for distinctive, important, and vivid memories and strongest in the right hemisphere. According to our model this is the moment when a stable pattern of activation is formed in the autobiographical memory knowledge base and linked to the frontally generated retrieval model: These changes in SCPs would seem to reflect this. Very rapidly after, memory formation activation shifted to the right hemisphere, and while a memory was held in mind, activation was detected in right frontal regions, posterior temporal regions, and in the occipital lobe. This right-hemisphere pattern of activation represents the fusion of activation across several different systems and is held in place by a retrieval model perhaps local to right frontal networks, although activation remained high in medial left frontal lobe too. The right-hemisphere pattern of activation remained present throughout the memory hold period. When the cue to forget the memory was presented there was a large and comparatively lengthy P300 with a growth of positivity (inhibition, dysfacilitation) in centro-parietal and right-hemisphere regions. This may have reflected an attempt to inhibit a memory-retrieval model as a way of "removing a memory from mind." However, negativity remained high at temporo-occipital sites, suggesting that inhibiting a fully constructed and maintained memory may be complex and operate over a time span of more than 5 s, which was the inhibitory period sampled in this study. These changes in SCPs as a memory is generated, held in mind, and then inhibited are exactly what our model predicts.

Recently we have been able to corroborate these SCP findings in a PET study of autobiographical memory retrieval (Conway, Turk, et al., 1999). In our PET study participants retrieved autobiographical memories to cue words while being scanned, and the patterns of activity arising during this task were contrasted with those in several control conditions, that is, cued recall of previously learned words, word reading, and viewing visual noise. The PET data unique to the autobiographical memory condition showed a very large area of left frontal activity extending through inferior, superior, and middle frontal lobe with peak foci in Broadman Areas (BAs) 45, 46, 8, and 6. In addition to this, reliable regions of activation were also detected in the left parietal lobe BA 39, left occipital lobe BA 18, and in the left inferior temporal lobe BA 20. According to our model and consistent with the SCP data this left fronto-temporal activation occurs in the early phase of retrieval while a memory is in the process of being constructed, whereas the parietal–occipital activation emerges when a memory is formed. In the PET study participants did not have to hold a memory in mind, and this may account for the failure to detect any unique right cortical posterior activation for autobiographical memories. Instead, strong activation of the right middle temporal lobe was uniquely associated with cued recall only. Overall, the PET data confirm the extensive involvement of left fronto-temporal networks in autobiographical memory construction, and the SCP data pinpoint this as occurring during retrieval (rather than when an autobiographical memory is held in mind or inhibited). Taken together the two studies suggest that the neurophysiological signature of autobiographical memories appears to be characterized by initial and widespread activation of networks in the left frontal and anterior temporal lobes, and to a lesser extent by right frontal activation, followed by activation in the right posterior temporal lobes and in occipital networks bilaterally while a memory is held in mind.

Finally, it is instructive to contrast the above findings with the only other PET study (Fink et al., 1996) specifically directed at autobiographical memory. In Fink et al., participants read sentences that named details of events from either another person's biography (impersonal) or from their own life (personal). In both cases participants were to imagine what happened in the named event detail. Very extensive right-hemisphere activation unique to the personal condition was detected, and this activation was particularly marked in the right prefrontal cortex and right temporal lobe, especially the right temporopolar cortex, and right hippocampal formation. These findings fit well with the SCP data reported earlier but are less consistent with the Conway, Turk, et al. (1999) PET data. It seems to us that the reason for this is that the stimuli used in the Fink et al. study considerably minimized the need for a retrieval model. This is because the sentences named details of (emotional) events from the participants' own autobiographical memory, which is known to speed autobiographical memory construction and reduce the number of search-and-verify iterations needed in evolving an effective retrieval model (Conway & Bekerian, 1987a). Thus, this is a case of direct access to autobiographical memory knowledge that effectively bypasses the retrieval model phase of generative retrieval and leads to fast formation of an autobiographical memory. In direct access we predict a reduced role of control networks in retrieval, and the absence of left frontal activation in the Fink et al. data confirms this. Generally, our model posits that when cues of sufficient specificity (autobiographical memory—specific, that is; see Conway, 1997a) are processed while a person is in retrieval mode, then an autobiographical memory will be very rapidly formed. In this case control processes of the working self operate only *after* a memory is formed when, presumably, they evaluate the goal relatedness of the accessed knowledge. In yet other cases when an autobiographical memory-specific cue leads to the formation of a stable pattern of activation in the knowledge base *but* the system is not in retrieval mode, then our model predicts that working-self control processes situated in left frontal networks would become active in the incorporation of the activated knowledge into current processing sequences or in keeping the knowledge apart from current tasks, that is, outside awareness. In summary, data from these three neuroimaging studies of autobiographical memory retrieval (Conway, Pleydell-Pearce, & Whitecross, 1999; Conway, Turk, et al., 1999; Fink et al., 1996) give broad and converging support to the model and its central claim that, in generative retrieval, control processes in the frontal lobes operate on knowledge in posterior networks interactively to construct a memory. In our view these neuroimaging findings confirm our interpretation of much of the behavioral and neuropsychological data reviewed earlier.

Part 5: General Discussion

We started this article with the proposal that autobiographical memories are transitory patterns of activation constructed across knowledge structures within an autobiographical knowledge base. In generative retrieval the formation of stable patterns is shaped by an interaction between the working self and the knowledge base that produces a retrieval model. Alternatively, in direct or spontaneous retrieval of memories, stable patterns form in response to the

effects of highly specific cues—such cues are in effect "retrieval models"—and it is only after this that the working self enters the construction process. In direct retrieval the goal structure of the working self determines whether or not a spontaneously constructed memory and other patterns of activation in the knowledge base will enter current central processing sequences. In general, the function of the SMS is to modulate the construction of memories and their influence on current processing, and this is because full instantiation of a memory in awareness requires the attenuation and even the temporary cessation of other forms of cognition (Conway, in press). Thus, the experience of remembering is controlled by the goal structure of the working self. However, the goal structure is itself influenced by the knowledge base that constrains what goals can be held and grounds the working-self goal structure in knowledge of past attempts at goal attainment.

Our cognitive–motivational model of autobiographical memory suggests that several distinct brain regions may subserve this type of remembering. It seems likely that the goals of the working self are represented in frontal-anterior temporal regions of the brain and, more specifically, in networks in the left frontal lobe (cf. Damasio, 1994). We suggest that networks in the left hemisphere mediate the formation of a retrieval model in right frontal cortex which is used to shape, by generative retrieval, a stable pattern of activation in the autobiographical memory knowledge base. The knowledge base itself may be represented primarily in networks in the right hemisphere and also bilaterally in posterior sites, and we note that our SCP findings (Conway, Pleydell-Pearce, & Whitecross, 1999) in this respect are highly consistent with those of Fink et al. (1996), who also found extensive right-hemisphere activation when autobiographical knowledge was processed. As a memory is formed, these regions become active, and once a memory has been established activation rises in right posterior neocortex. While a memory is maintained in awareness, networks in right frontal, posterior temporal, and occipital sites remain active, and this, by our view, is the transitory pattern of activated knowledge under central control fused over several different memory subsystems that constitute a specific memory. We propose that networks in both the right and left frontal lobes maintain a retrieval model that coordinates activation in regions posterior to it. Possibly, abstract lifetime period knowledge is stored in right frontal sites, knowledge of general events in the temporal lobes, and ESK in occipital–parietal networks. In summary, memories are patterns of activation fused over several right-hemisphere brain regions by a frontally held retrieval model that itself evolved through networks in left frontal and left anterior temporal networks.

Types of models such as the cognitive–motivational model of autobiographical remembering that we have developed here synthesize research from many different domains and partly because of this become difficult to evaluate; that is, there are no simple or direct ways in which to test the model. Our view is that even when there are no simple tests of a model—and this may be true for most complicated forms of cognition—there is a range of phenomena to which the model should be applicable, and it is this that constitutes the main test of its validity. In the area of autobiographical memory there are phenomena the understanding of which any perspicacious theory should be able to make a contribution to. S. J. Anderson and Conway (1997) provided a list of some of these phenomena, and here we single out two central items from their list: (a) how to account for the three components of the life span retrieval curve and (b) dysfunctional memory in PTSD and clinical depression. We show how our cognitive–motivational model can be used to understand these normal and abnormal features of autobiographical remembering.

Patterns of Memory Retrieval

The model of the construction and temporary representation of autobiographical memories that we have proposed deals with what has been termed the *microstructure* of autobiographical memory (Conway & Rubin, 1993). But autobiographical memory also has a macrostructure that emerges in the life span retrieval curve (Conway & Rubin, 1993; Rubin, 1982; Rubin et al., 1998; Rubin, Wetzler, & Nebes, 1986; Schuman, Belli, & Bischoping, 1997; Schuman & Rieger, 1992). The life span retrieval curve can be observed in many situations but is most clearly evident when individuals freely recall events from their own lives and then date each event (see Rubin et al., 1998). When memories are then plotted according to age at encoding the life span retrieval curve is observed, and Figure 2 shows an idealized version of the curve emphasizing the three components: childhood amnesia, the reminiscence bump, and recency.

Childhood amnesia. There have been numerous theories of the causes of childhood amnesia from Freud (1915/1957), who proposed repression of this period due to the potentially psychodynamically destabilizing material retained from infancy, and Waldfogel (1948), who argued for a general developmental increase in the ability to encode memories that was simply part of general intellectual development (see Howe & O'Sullivan, 1997, and Wheeler, 2000, for contemporary versions of this), to more recent theories that emphasize the role of developing linguistic abilities and the nature of social interaction patterns (Fivush, Haden, & Reese, 1996; Fivush & Reese, 1992; Harley & Reese, 1999; K. Nelson, 1993). Reviews and evaluations of these various theories can be found in Pillemer and White (1989) and in Howe and Courage (1997), and here we first focus on the model proposed by the latter authors. Howe and Courage (1997) argued that it is not until the development of what they termed the *cognitive self,* at around 24 months of age, that the infant is able to encode experiences in terms of self and establish an autobiographical knowledge base. According to Howe and Courage, the cognitive self emerges when the infant is able to distinguish the *I* from the *me,* that is, when the infant is able to experience self as an object. Howe and Courage commented that the *I* "is a subjective sense of the self as a thinker, knower, and causal agent, and the *me,* an objective sense of the self with unique and recognizable features and characteristics" (1997, p. 506; see too Baddeley, 1994). The important point here is not that the pre-24-month infant cannot retain event knowledge (infants much younger than 24 months retain event knowledge; Rovee-Collier, 1997), but rather that this knowledge is not organized in terms of a structured self-system. Howe and Courage (1997) also went to some lengths to reject the views (a) that the emergence of autobiographical memory occurs as various brain regions supporting this type of memory mature epigenetically (see C. A. Nelson, 1995) and (b) that autobiographical remembering entails processes that are unique and specific to it and that do not feature in other types of remembering.

In general, our view of autobiographical memory is in agreement with Howe and Courage's (1997) model of childhood am-

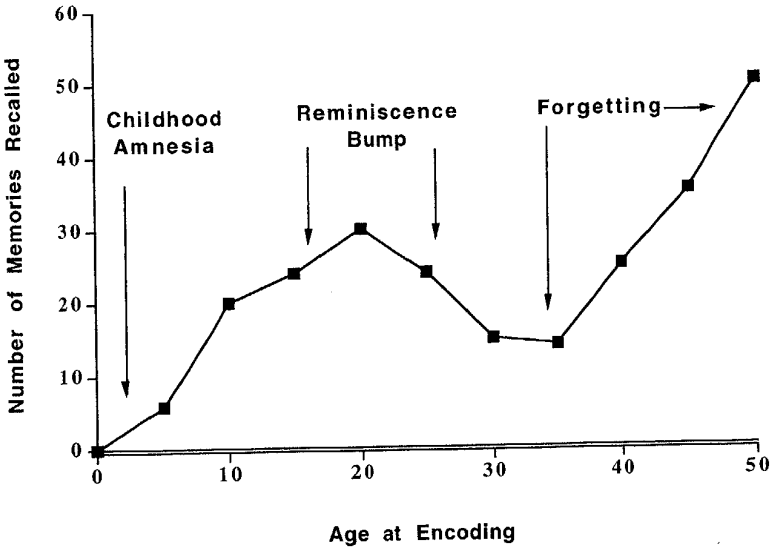

Figure 2. Idealized representation of the life span retrieval curve.

nesia and their wider view of autobiographical memory, although there are also some important differences. For instance, our approach proposes that knowledge is retained because of its relation to current goals; that is, it is "filtered" through the currently active goal structure and is later retrieved in terms of the goal structure then active. Because infants have goals, it follows that infants retain durable autobiographical knowledge relating to their goals. However, the goals of the infant are likely to be very different from those of an older child or adult, and, moreover, it seems unlikely that infants would have a fully formed self-system with different representational domains for actual, ideal, and ought selves. Nonetheless, we have already seen that just-verbal two-and-a-half-year-olds have causal understanding of emotional experiences similar to that of adults and must also have some sort of (preverbal) representation (IWM) of their attachment style—a representation that remains available into adulthood (Steele & Steele, 1998). Thus, it seems unlikely that infants would not have goals for reducing self-discrepancies as well as a rapidly structuring self-system, possibly based on attachment style. The goals of infants are most probably more associated with basic needs and motives for nurturance, dependence, separation, and so on, which mediate the encoding of goal-related experience while the structure of the self-system is still forming and in the absence of any *abstract* autobiographical memory knowledge. By our view, infant (pre-2-year-old) autobiographical memory comprises mainly ESK stored nonconceptually in posterior brain locations. Possibly some of this autobiographical knowledge becomes structured around a representation of significant figures in the infant's life and as processes of separation–individuation (Mahler, Pine, & Bergman, 1975) unfold, so the basis gradually emerges for representing more abstract autobiographical knowledge (general events) that act, at retrieval, to contextualize ESK. Given the high probability of at least some prebirth memory (cf. Rovee-Collier, 1997), it seems plausible to postulate an early emerging, fast-developing memory system that encodes ESK, and our suggestion is that this is the medial temporal lobe memory system (Moscovitch, 1995; Squire, 1992). That this knowledge cannot be later retrieved may relate, at least in part, to the extent of the disjunction between the goals that originally mediated encoding (during infancy) and the goals operating at retrieval. When there is little overlap or continuity between encoding and retrieval goal structures, then effective retrieval models cannot be constructed and specific memories cannot be formed.

In fact, the decline in access to autobiographical memories below the age of 5 years takes, in general, an exponential form (Wetzler & Sweeney, 1986; but see Eacott & Crawley, 1998, and Usher & Neisser, 1993, for exceptions), suggesting that there may be another major change in the self or the goals of the self at around the age of 5 years. It is also of some relevance that the frontal lobes undergo extensive and constant postnatal development up to 4 to 5 years of age and show further signs of continuing neurophysiological developmental change into adolescence (cf. Kolb & Wishaw, 1995). During the first year of life the density of synapses in the frontal lobes increases such that the infant frontal cortex contains many more synapses than the adult. From the age of about 12 months a decline in synapses begins, and this is most marked from about 5 years onward up to 16 years after which the frontal cortex stabilizes with no further change until old age (Huttenlocher, 1979). The interpretation of this is that synaptic degeneration during development reduces redundancy and makes processing in frontal networks faster and more efficient (Kolb & Wishaw, 1995). An intriguing possibility is that these neurophysiological developmental changes in frontal cortex may reflect the establishment of control processes, some of which will act to inhibit activation in the autobiographical knowledge base from entering other processing sequences. The emergence of the ability to view oneself as an object and the state of self-awareness that accompanies this may be one of the major control processes, for without this facility individuals could not know that they were remembering. It is inherent in concepts such as retrieval mode

(Tulving, 1983) and focusing (Schacter et al., 1998) that the self can take itself, in the form of the autobiographical knowledge base, as an object, and it is this organizing function of the cognitive self, mediated by frontal networks, that Howe and Courage (1997) singled out as the major developmental change that enables autobiographical remembering. We agree with Howe and Courage but add that changes in goals and goal structures as well as changes in the ability to control memory, associated with neurophysiological development in the frontal lobes, also influence what later will be accessible.

Our cognitive–motivational account contrasts with the social interactionist account of childhood amnesia, which proposes that it is not until children learn the form for reporting past experiences and come to understand the social function of autobiographical memories, namely, developing a life history that can be retold to others, that memories become easily available (cf. Bruner & Feldman, 1996; K. Nelson, 1993). The research focus here is on the types of linguistic styles (elaborative vs. restrictive) that characterize mother–child talk about the past (see Harley & Reese, 1999, for a review of the main findings). The claim of the social interactionists that the *primary* aim of autobiographical memories is to share personal memories with others (Fivush et al., 1996) contrasts with our suggestion that the primary aim is to ground the self and in so doing form part of the SMS and allow a functional self-system to operate—processes quite independent of whether or not memories are shared.[3] These two views are not, however, mutually exclusive, and it certainly must be the case that one of the functions of autobiographical memory is to facilitate the sharing of personal knowledge (see Pillemer, 1998). It may be that some sort of "pluralist" model is required as Harley and Reese (1999) suggested (see too Fivush, 1998), and certainly their data showing how measures of narrative styles and cognitive self predict different aspects of autobiographical memory retention in children appear to incline theorizing in this direction. However, it seems unlikely that the social interactionist approach, at least in its current formulation, can provide much in the way of explaining the relation of goals to memories, distortions of memories, neuropsychological and clinical disruptions of autobiographical memory, changes in autobiographical memory in adolescence, or different types of autobiographical knowledge. For this reason we suggest that the SMS goal-based account of autobiographical encoding and retrieval provides a more fundamental explanation of childhood amnesia: Memories are records of progress in attaining personal goals, and we have no choice but to form them no matter what our linguistic experience. The key factor at retrieval is goal compatibility, and this is what determines memory construction. The goals of the infant are so disjunct and incompatible with those of the older child and adult, that autobiographical knowledge relating to these goals encoded during infancy mostly lies outside the range of what is accessible by the more mature SMS.

The reminiscence bump. The second component of the life span retrieval curve, usually only observed in individuals older than about 35 years, is the so-called *reminiscence bump* (Rubin et al., 1998; Rubin et al., 1986). The reminiscence bump covers the period when a rememberer was aged 10 to 30 years, and it can be seen in Figure 2 that this period is associated with an increase in frequency of recollection. Rubin et al. (1998; see too Conway & Rubin, 1993) reviewed the many studies that have observed the reminiscence bump using a very wide range of different procedures, and Rubin et al. (1998) also reviewed a more recent set of findings showing the reminiscence bump when people are asked to name favorite films, music, books, important world events, and so on. In short, converging evidence indicates that the knowledge acquired during the reminiscence period is highly accessible and more accessible than knowledge outside this period but not as accessible as knowledge of recent experiences.

Rubin et al. (1998) considered several explanations for the bump and favored an account that emphasizes the novelty of experiences occurring during the 10- to 30-year-old period and the effect such novelty has on memory. Essentially, many first-time experiences and experiences novel in other ways are processed to a deeper level while they occur and become integrated with existing knowledge in distinctive and accessible ways. Memories of these experiences may also be rehearsed more frequently than memories of events occurring outside the period. Rubin et al. (1998) noted too that the period covered by the bump is one of change and development for the individual often followed by a lengthy period of stability, thus rendering the whole of the reminiscence period more distinctive and novel than the period that follows it.

However, the period covered by the reminiscence bump is also a critical period for the formation of a stable self-system, and Erikson (1950) originally observed that there is major development of identity in late adolescence. Important tasks here are identification of what one is (development of an actual self), development of social identity (ought self), and development of new personal adult goals (ideal self). Also occurring during this period is the formation of generation identity (Mannheim, 1952), which takes place through identification by the individual with a particular social group, and this too may lead to the preferential retention of knowledge of the social world of early adulthood (Conway, 1997b; Holmes & Conway, 1999). At a more general level several researchers have identified this period as one in which the beginnings of a "life story" first emerge (Fitzgerald, 1988; McAdams, 1985; Robinson & Swanson, 1990). In a recent development of this Habermas and Bluck (in press) reviewed the evidence that children below the age of about 15 years do not have integrated life narratives; indeed instruments such as the AAI are only used from mid-adolescence onward because they do not produce coherent integrated accounts with younger people. Fifteen-year-old and younger accounts of life stories take the form of descriptions of specific often unrelated memories or of groups of unrelated memories. However, very frequently these young participants are unable to make any response to the request to relate their life story (see Habermas & Bluck, in press). In contrast, late adolescence sees the emergence of an ability to provide a life story narrative, and Habermas and Bluck argued that this is because of the development of a *life story schema* at this age. A life

[3] Lying behind these two views are theoretical assumptions about the evolution of memory and language. The social interactionist approach assumes that language drove the emergence of autobiographical memory. In contrast, the SMS view assumes that autobiographical memory was one of the cognitive developments that drove the emergence of language. By this view some sort of structured self-system, with a history, conferred a survival advantage on an individual, and, moreover, this then in turn set up an evolutionary pressure (for the development of language), because those who could communicate about self to others had yet a further survival advantage.

story schema is conceptualized as a latent knowledge structure that facilitates the generation of life narratives. This, then, is one of the major developments of late adolescence and clearly represents a fundamental change in autobiographical memory.

Related to this, Holmes and Conway (1999) found two components in the reminiscence bump that strongly implicated changes in the self as the critical factors driving encoding during this period. The first component covered the period, roughly, when the rememberer was aged 10 to 20 years and was marked by a focus on memory for external public events, especially for those events that carried the "zeitgeist" of the period. This early part of the reminiscence bump reflects development of social and generational identity, and goals of the individual during this period may be to understand and integrate themselves with society at large, possibly by creating a life story schema, and hence the retention in memory of newsworthy public events. The second component identified by Holmes and Conway (1999) covered the period 20 to 30 years of age and, in contrast to the earlier component, was marked by recall of private events relating to experiences of intimacy in various personal relationships. The goal of attaining intimacy with significant others and with a close social group guided preferential retention of events during this period. Finally it is important to note that although it is undoubtedly the case that many novel experiences occur during this period and, by virtue of their distinctiveness, such events are well remembered, it is not the case that this period is solely dominated by memories of first-time experiences. Fitzgerald (1988), for example, in a content analysis of memories recalled by older adults from the reminiscence bump found less than 20% of memories to be of first-time experiences. The majority of memories were of events of idiosyncratic relevance to the individual rememberer and, as such, reflected the personal goals and projects of the individual during this time.

On the basis of the above evidence, we conclude that the reminiscence bump reflects preferential retention of events from a period of consolidation of the self. During this period, as Erikson (1950) originally suggested, long-term goals and plans are formulated, the individual becomes integrated with society and with an immediate social group (i.e., forms a generation identity; Conway, 1997b), forms long-term allegiances and friendships, and develops a life story schema and, as a result, the capacity to generate life narratives. We agree with Rubin et al. (1998) that after this period, for most individuals, the self and its goals do not change either rapidly or radically, at least for the majority of individuals. Our theory predicts that for those individuals who do experience radical change to the self (after the age of about 35 years) then later periods of enhanced recall may result in addition to the reminiscence bump (see Conway & Haque, 1999, for recent evidence of this). In the more usual case, however, in which goals change progressively over periods of years and not in an abrupt or disjunct way then there is only a single period of enhanced recall, and this is the reminiscence bump. In our model of autobiographical memory, highly self-relevant and self-formative events that were experienced during a period marked by the generation of long-term goals remain highly accessible in memory because of their enduring association with the current goals of the working self. This association may be one in which memories of certain events (self-defining events) stand as progenitors of classes of goals that, over time, change in content but not type, that is, mastery, intimacy, and so on. Perhaps, memories of such self-defining experiences act as organizers in the autobiographical knowledge base where they might function as *self*-reference points. Thus, memories of these experiences, which occur between the ages of 10 and 30 years, may be more available than memories from other periods because they relate to enduring personal goals and have a central organizing role in the autobiographical knowledge base. Finally, in this section we note, although we do not develop it further here, that this account of the reminiscence bump can be generalized to other individual-differences findings in autobiographical memory such as gender (e.g., P. L. Davis, 1999; Seidlitz & Diener, 1998) and cross-cultural differences (e.g., Han, Leichtman, & Wang, 1998; Mullen, 1994; see Conway & Haque, 1999, for an application of the theory to an actual cross-cultural autobiographical memory difference).

Recency in autobiographical memory. The final component of the life span retrieval curve shows a powerful effect of recency (see Figure 2). Curiously, little research in autobiographical memory has been directed at the retention of recent experiences, although some aspects of Linton's (1986) diary study of her own memory suggest that memories become integrated with the knowledge base only over a period of approximately 24 months. Other theorists have also suggested a potentially long consolidation process for the retention of episodic knowledge (J. L. McClelland, McNaughton, & O'Reilly, 1995; Moscovitch, 1995; Squire, 1992). By this view knowledge is initially retained in hippocampal circuits and becomes established in neocortical areas only if it is rehearsed. (But note that Conway, Turk, et al., 1999, did not find selective hippocampal activation for recent vs. remote memories, which does not support this view.) Rehearsal may be important in the retention of recent everyday experiences; however, by our view it is the extent to which an experience engages the SMS and its goal structure that is decisive in determining retention. But disentangling the discrete effects of rehearsal and goals is probably not possible given that events that engage the SMS result in memories that are thought and talked about. Nevertheless, a prediction from our view is that the availability of memories from recent periods will be mainly determined by the degree of their goal-relatedness: Events that intensively engage the working self will be strongly associated with central working-self goals and so give rise to memories that, because of their close association with current goals, remain highly available. As the content of the goals of the working self gradually changes over time the high availability of previously goal-relevant knowledge decreases, and the construction of once highly available memories is rendered less complete and more effortful.

Intrusive and Overgeneral Memories

Autobiographical memories can take extreme forms in different types of clinical disorders, and two types—PTSD and clinical depression—are of interest, because in the former memories are vivid whereas in the latter they are impoverished. In PTSD one of the major symptoms is the repeated and intrusive recollection of the traumatic event and often of a specific sensory–perceptual detail. Initially, the trauma memories are disorganized fragmentary collections of vivid, near-experience, sensory–perceptual details that gradually settle into a more coherent and organized pattern; indeed stabilizing the memory is often one of the initial goals of therapy. The content of trauma memories remains highly sensitive

to cues, and any cues that access parts of the memory may lead, often do lead, to flashbacks and the vivid reliving of part of the trauma (Brewin, 1998; Ehlers & Steil, 1995; van der Kolk & Fisler, 1995). Furthermore, although all PTSD patients show this symptomatology, some recover within weeks and months, whereas for others the symptoms persist for months and years (Ehlers & Clark, 1999).

A key feature of traumatic experiences is that they present a threat to current plans and goals, and this is a threat to which the working self cannot adapt. As there are no currently active goals that can be used to guide encoding and the integration of the experience, either the event is not encoded, resulting in traumatic amnesia, or if encoded it cannot be integrated with the knowledge base because there are no active goals that can mediate integration. In this latter case the result is an ESK representation with no contextualizing abstract autobiographical knowledge (a memory that is, perhaps, solely a product of the medial temporal lobe memory system). Instead, the trauma ESK will be strongly associated to the working self and its goals rather than the autobiographical knowledge base. This latter may occur because of a powerful negative association between the trauma knowledge and the goals active at the time of the traumatic experience: As the trauma knowledge potentially negates all goals when it is represented in long-term memory it is represented in terms of all goals (possibly to varying degrees). The suggestion from our model is then that ESK from the traumatic experience becomes associated in long-term memory *by default* with the goals of the working self active during the trauma. This occurs by default because there are no other knowledge structures that can be accessed by the trauma knowledge, which itself contradicts or violates active goals *that might otherwise have been used to integrate the experience with the knowledge base.* As a result of this each time any current goal is activated the probability of activating the trauma ESK increases. No doubt inhibitory processes can be brought to bear on the activated knowledge, but this may also entail inhibiting a goal, the costs of which might outweigh the benefits. Moreover as progressively more goals become active they provide multiple sources of activation to the trauma ESK, which eventually exceeds inhibitory thresholds and intrudes into awareness, causing the system to enter retrieval mode, initiate recollective experience, and so disrupt or prematurely halt other cognitive tasks as an intrusive memory is formed.

For those individuals who experience trauma but who nonetheless are able to use the knowledge base via the goal structure of the working self to encode the experience, then the resulting autobiographical knowledge will become integrated with the knowledge base where its subsequent recollection can be controlled. Thus, for instance individuals with perhaps an unrealistic belief in their ability to control a vehicle, arising possibly from a goal of mastery, when involved in a serious road traffic accident (RTA) might encode their experience of the RTA trauma in terms of the working self (i.e., as further evidence in support of their belief that they have achieved or not achieved mastery) and so access the SMS knowledge base. As a consequence, knowledge of the RTA becomes integrated with the knowledge base (other "mastery" memories) and does not intrude on consciousness. Thus, the SMS model of autobiographical memory can provide a potentially fruitful way in which to account for intrusiveness and vividness of PTSD memories and also for individual differences in the formation of PTSD symptoms.

For those trauma survivors who are, however, unable to integrate the trauma experience that, consequently, takes the currently active goal structure of the working self (in its entirety) as its context, it will not be until the current goal structure itself changes that intrusions of the memory decrease. This is because the trauma ESK will always be highly available as it is activated by activation of the goals and plans of the working self, which, presumably, are to some extent always activated. One implication of this line of reasoning is that when trauma memories are recalled intrusively this will be mediated by networks in frontal (possibly left frontal) and sensory processing areas (e.g., occipital cortex) but not, or to a reduced degree, in networks located in temporal regions. A further implication of the model is that the excessive availability of the trauma ESK might be reduced if the ESK itself can be linked to contextualizing autobiographical knowledge such as lifetime periods and general events. Accessibility could then be controlled by the structure of autobiographical knowledge and by the influence of control processes in modulating and inhibiting access to the knowledge base. A general point that derives from this, and from our earlier specification of the model, is that *any* ESK that comes to mind is destabilizing in the sense that it will put the system into retrieval mode and so interrupt the operation of other processing sequences (Conway, in press). Thus, an important assumption of our approach is that autobiographical memory knowledge structures and the executive processes of the SMS evolved to control the instantiation of ESK in awareness. ESK is automatically activated by an appropriate cue, and when ESK is not integrated with the knowledge base or when control processes malfunction or have yet to fully develop, then vivid sensory–perceptual details of a past experience can intrude into conscious awareness.

Thus far, we have confined the discussion to memories of a single traumatic event, but repeated trauma may also give rise to intrusive sensory–perceptual memories and also to the inhibition of memories. In our view the same processes underlie intrusive memories for repeated experiences of trauma, and these also give rise to a suspension of current goals and a direct linking of ESK to the working self. However, as the traumatic experiences are repeated, they will eventually result in a range of trauma experiences attached to the goal structure of the working self. In effect, a trauma knowledge structure will have been created, and this may become represented as a distinct part of the autobiographical knowledge base with a direct and powerful connection to the goal structure of the working self. We view this as analogous to the creation during development of the autobiographical knowledge base itself. Once the cognitive self emerges (Howe & Courage, 1997), ESK becomes directly linked to the infant working-self goal structure. As ESK accumulates so knowledge structures gradually develop, with like experiences being associated with each other as a gradual accretion of personal schemas, and other more abstract autobiographical knowledge structures take place (cf. K. Nelson, 1993). In the case of repeated trauma, although the process may be the same, it is complicated by the fact that a goal structure and knowledge base already form the SMS. Thus, a distinct trauma knowledge structure forms that has a direct link to the working self, that is, that does not require the usual extended generative retrieval in order to construct a memory. This direct link will

remain as long as the goal structure of the working self does not change. As changes in goals take place—that is, some are achieved, others abandoned, and new goals adopted—then the direct link will weaken, reducing accessibility to the trauma knowledge. Again we assume that this is what occurs in normal forgetting, in which as the goal structure changes so access to knowledge encoded in terms of no-longer-active goals becomes attenuated. This clearly suggests that it may be possible to reduce access to the trauma knowledge structure by maintaining a working-memory goal structure that attenuates or inhibits access by holding goals and plans partly or completely disjunct with the trauma knowledge. Thus, we note but do not discuss in further detail that once autobiographical knowledge is organized into a knowledge structure, this may render that knowledge more amenable to inhibition by executive control process simply because it is a distinct structure to which access can be isolated (Conway, 1997a).

This account of PTSD and traumatic amnesia is highly related to several other current approaches, two of which we consider in further detail here. Levine et al. (1999) and Stein, Ross, Sheldrick, and Fergusson (2000) drew on Stein's goal-directed theory of behavior (Stein & Levine, 1989; Stein & Trabasso, 1992; Trabasso & Stein, 1994) to account for various aspects of affect in traumatic experiences and in memory for emotional experiences shared by children and adults. According to this view "goals become active when a person wants to either attain or maintain a desired state or avoid an undesired state" (Stein et al., 2000). Traumatic experiences, then, cause intense negative emotions because they reduce or remove goal attainability, including whole sets of goal hierarchies from very specific goals (e.g., to drive to work) to highly abstract goals (e.g., to be successful). Our model is focused very directly on autobiographical remembering rather than the causes of emotional experience; nevertheless our approach and that of Stein and coworkers are highly compatible. We would add only that, by our view, a critical precursor of PTSD would be the moment and extent to which the individual realized that his or her goals could no longer be attained. It may well be that intense feelings of surprise and unreality (not themselves necessarily negative emotions) in sudden onset traumas indicate the rapid disjunction of the goal structure from reality following an appraisal of overwhelming threat. By our view this would lead to the encoding of disconnected ESK details in terms of the working self rather than autobiographical memory knowledge base and, hence, to intrusive recollection of ESK. This emphasis on appraisal of threat (to active goals) as a precursor, and indeed a cause, of PTSD also forms a central tenet of Ehlers and Clark's (1999) cognitive model of long-lasting PTSD. According to these theorists two major processes underlie PTSD memory symptoms: (a) individual differences in the appraisal of threat and (b) individual differences in how and to what extent the trauma knowledge is assimilated to the autobiographical memory knowledge base. We do not further consider here the extensive findings reviewed by Ehlers and Clark, nor do we explicate their detailed and elegant theory; however, we do note a convergence among our own work, that of Stein and her group, and that of Ehlers and Clark and their group on a common theoretical account of the causes of PTSD. In the case of our own work we can also uniquely offer an account of how the intrusive trauma knowledge might be represented in a highly accessible form in long-term memory, and we emphasize too our view that intervention directed at changing working-self goals might constitute a significant form of treatment as this should reduce the accessibility of trauma ESK.

Finally, in this section we consider an autobiographical memory disorder that appears to be the exact opposite of intrusive memory in PTSD, namely overgeneral memory in clinical depression. J. M. G. Williams and his colleagues (see J. M. G. Williams, 1996, for a review) in a systematic series of studies established that many patients with clinically high levels of depression appear unable to generate fully detailed autobiographical memories. Instead these patients, when interviewed or cued in experimental studies, respond with what J. M. G. Williams called "categoric memories"; that is, they will stop retrieval at a point at which they have only categories of information in mind, for example, visits to the hospital, walks in the park, and so on. These retrieval attempts rarely, if ever, result in construction of a full memory. J. M. G. Williams proposed that these patients suffer from "mnemonic interlock," which arises because as a patient accesses general event knowledge he or she also accesses other (negative) self-referring knowledge and (control processes) then terminates the search at this point. Clearly it makes some adaptive sense to terminate a memory search that threatens to access knowledge that may destabilize the goals of the working self and cast the whole system into turmoil. As the net effect of overgeneral recall is in preventing the generation of specific memories, one way to view it is as a *dysfacilitation* of the retrieval process. It is a dysfacilitation in the sense that the generation phase of retrieval is terminated before an appropriately detailed retrieval model can be constructed.

A question that then arises is, why is it that PTSD patients do not also show a similar dysfacilitation and only retrieve overgeneral memories of their trauma experience(s) and so defend themselves against intrusive memories? There is no clear answer to this; however, Brewin (1998) recently pointed out that many depressed patients also have intrusive, flashback-type memories of traumatic experiences that are vivid and detailed while simultaneously presenting with overgeneral memories. Indeed, PTSD patients themselves may experience clinical levels of depression and when they do will quite possibly also have overgeneral memories. We suggest that overgeneral memories indicate an attempt at inhibitory control of memory construction. On some occasions the attempt is successful and retrieval terminates early; on others it is unsuccessful and a memory is constructed—a memory that may evoke much painful affect in the rememberer. Our prediction is that whether the dysfacilitation is successful or not depends on several factors, one of which is how rapidly ESK enters into the process of retrieval. If ESK is encountered rapidly, as might occur with a specific cue or if ESK is associated directly with working memory goals, then extra resources will be needed to inhibit it, resources depressed patients do not have (J. M. G. Williams, 1996). The most effective strategy is, therefore, to rapidly terminate the search before difficult-to-inhibit stable patterns of activation become established in the knowledge base, as would follow the activation of ESK.

Concluding Comment

The model of autobiographical memory developed in this article draws on data from many different sources and brings these together in the form of a proposal for an SMS. The SMS is a "superordinate" memory system that has a knowledge base and set

of hierarchically structured goals (working self). The knowledge base is conceived as distributed over several other memory systems, the outputs of which, or patterns of activation within which, are coordinated by (a) the organization of autobiographical knowledge structures and (b) a retrieval model generated through an interaction of the working self with the knowledge base during memory construction. Unique features of the model are that (a) the self and memory are brought more closely together than in other models (e.g., Johnson & Chalfonte, 1994; Schank, 1982), (b) it suggests how knowledge may be encoded, (c) it is supported by neuroanatomical findings and, moreover, provides a scheme for organizing these complex neuropsychological findings (in parts it is closely related to models proposed by Damasio, 1989, and Moscovitch, 1995), (d) it can be applied to memory dysfunctions in clinical disorders, and (e) it offers a cognitive–motivational account of memory—an account that attempts to show why we remember what we do remember of our everyday lives.

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