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Memory and the self ☆

Martin A. Conway

The Leeds Memory Group, Institute of Psychological Sciences, University of Leeds, Leeds, UK

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Abstract

The Self-Memory System (SMS) is a conceptual framework that emphasizes the interconnectedness of self and memory. Within this framework memory is viewed as the data base of the self. The self is conceived as a complex set of active goals and associated self-images, collectively referred to as the *working self*. The relationship between the working self and long-term memory is a reciprocal one in which autobiographical knowledge constrains what the self is, has been, and can be, whereas the working self-modulates access to long-term knowledge. Specific proposals concerning the role of episodic memories and autobiographical knowledge in the SMS, their function in defining the self, the neuroanatomical basis of the system, its development, relation to consciousness, and possible evolutionary history are considered with reference to current and new findings as well as to findings from the study of impaired autobiographical remembering.

Keywords: Autobiographical memory; Episodic memory; Goals; Recollective experience; Déjà vu; Amnesia; Neuroanatomy of memory; EEG; fMRI; Evolution of memory

A key feature of the approach taken to memory here, is that cognition is driven by goals: memory is motivated. This approach is embodied in a conceptual framework termed the *Self-Memory System*, (SMS, Conway & Pleydell-Pearce, 2000; Conway, Singer, & Tagini, 2004) and the principal aim is to elaborate the nature of and rationale for the SMS. Findings from various domains are used to illustrate aspects of the SMS but a systematic review of the full range of findings is not undertaken (several very detailed reviews are currently available; see, for example, Conway & Pleydell-Pearce, 2000; Conway, Singer et al., 2004; McAdams, 2001, and edited volumes by Bluck, 2003; Hackmann & Holmes, 2004; Beike, Lampien, & Behrand, 2004; Skowronski, 2004). The SMS consists of two main components, *the working self* and the *autobiographical memory knowledge base*. When these components interlock in acts of remembering, specific autobiographical memories can be formed. Each, however, can operate independently and possibly enter into processing sequences other than those mediating memory. Both components and their interaction in remembering are considered in detail in this article. In the opening section, two general distinctions underlying the SMS framework are outlined. These are, first, a distinction between the self-coherence of autobiographical knowledge and how it does or does not correspond to experience and, second, a distinction between very recent memories and long-term retention. Subsequent sections consider in turn, the working self, the autobiographical knowledge base, the construction of autobiographical memories, and the neuroanatomical basis of the system. The

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E-mail address: M.A.Conway@leeds.ac.uk

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discussion closes with new proposals concerning the types of memory system that might mediate autobiographical remembering and the development of these systems ontogenetically and phylogenetically.

Constraints and types of memories

In this section, general issues relating to accuracy of memory, the self, and goals are outlined that conceptually frame empirical findings from the study of both normal and abnormal remembering. One starting point for current thinking about the nature of autobiographical remembering derives from the distinction made by Russell (2001, Chapters 12 & 13 in *The Problems of Philosophy*) between philosophical theories of truth that depend on *coherence* (of propositions) versus those that depend on *correspondence* with a fact.[1] A version of this distinction applied to human memory is useful in conceptualizing various aspects of autobiographical remembering.

Coherence and correspondence

Human memory, as William James (1890/1950) observed, is a major component of the self. Indeed, it has often been observed and long been known that memories may be altered, distorted, even fabricated, to support current aspects of the self, e.g., Bartlett (1932), Freud (1899, 1915), Greenwald (1980), Loftus (1993), Loftus and Ketcham (1994), Rapaport (1952/1961), Ross (1989). This is referred to here as *coherence* or *self-coherence* (Conway, Meares, & Standart, 2004). Coherence is a strong force in human memory that acts at encoding, post-encoding remembering, and re-encoding, to shape both the accessibility of memories and the accessibility of their content. This is done in such a way as to make memory consistent with an individual's current goals, self-images, and self-beliefs (as Greenwald, 1980, originally noted). Thus, memory and central aspects of the self form a coherent system in which, in the healthy individual, beliefs about, and knowledge of, the self are confirmed and supported by memories of specific experiences. By way of illustration consider for example a perhaps not uncommon occurrence: supporters of a football team recalled events from an important match that confirmed their belief in the sportsmanship and high skill level of the players, despite the fact that their team had clearly played a very physical and unsportman-like match (Hastorf & Cantril, 1952). Such biases in memory in favor of core aspects of the self are pervasive signs of coherence. Indeed Rapaport (1952/1961), in a classic review of the relation of emotion to memory, commented that memory should be conceived of "not as an ability to revive accurately impressions once obtained, but as the integration of impressions into the whole personality and their revival according to the the needs of the whole personality (p. 112–113)." The converse, however, extreme violations of coherence when memories undermine or contradict important parts of the self, are only usually present in psychological illnesses or following brain damage. Baddeley, Thornton, Chua, and McKenna (1996) reported a series of cases illustrating these types of striking violations of coherence in hospitalized schizophrenics. For instance, a young man who believed himself to be a famous rock guitarist also knew that he could not play the guitar, another patient believed himself to be a Russian chess grand master even though he had never been to Russia, could not speak Russian, and was regularly beaten at chess by fellow patients, and so on. Downes and Mayes (1994) report an interesting case of a neuropsychological patient with a vivid and intrusive memory of having a bitter argument with his father the previous evening even though, at the same time, he could recall attending his father's funeral some years earlier. When the self and autobiographical memory become disconnected in this way, so that memories no longer 'ground' core beliefs of the self, then delusions and confabulations emerge. Disorders of coherence will be considered further in the later section.

These are extreme violations of coherence and perhaps only arise, frequently and prominently, in psychological and neurological illnesses. They nonetheless quite powerfully suggest the importance of coherence to a stable self, one which can operate effectively on the world. Indeed, it seems that in the healthy individual a variety of processes may act to self-regulate and ameliorate the effects of self-dissonant memories. Beike and Landoll (2000) found that dissonant memories were responded to with a variety of strategies including outweighing, justification, and closure. Thus, an individual who recalls a memory of a happy experience from a period of their life they evaluate as unhappy, might categorize the dissonant happy memory as being an exception in a period of otherwise unhappy experiences (outweighing), or they might consider the remembered event to be a justifiably happy one in an otherwise unhappy period, or they may have some closure on the dissonant memory, accept that it was unusual for the period, but not require any further processing. These are all cognitive reactions to dissonant memories. Another reaction, however, is that of rumination and preoccupation with memories of difficult and discordant experiences. In the well individual this may be manifest as 'worry' whereas in psychological illness it may take a more intrusive, repetitive, and malignant form. It seems then that autobiographical memory is

[1] I am particularly indebted to the philosopher Dr. Christoph Hoerl, from the University of Warwick, for directing me to Russell's discussion of this distinction.

dominated by the 'force' or 'demand' of coherence. A stable, integrated, self with a confirmatory past that yields a consistent and rich life story (Bluck & Habermas, 2001) constitutes a self that is able to operate effectively, achieve goals, and relate to others in productive ways (Bluck, 2003). A coherent self will have high self-esteem and a strong positive sense of well being (see Csikszentmihalkyi & Beattie, 1979 & Conway, Singer et al., 2004, for a review), both powerful predictors of physical health. Thus, the benefits of coherence may then be considerable.

Set against the force of coherence is the demand of correspondence. Conway, Meares et al. (2004) argued that from an evolutionary perspective a memory system that did not maintain an accurate record of goal processing and the effects of goal processing would be unlikely to survive. Memory then should correspond to experience. On the other hand, a system that maintained literal or even highly detailed records of moment-by-moment experience would be faced with insurmountable problems of storage and retrieval. The memory system is, therefore, faced with several mutually contradictory demands. One is to represent reality as this is experienced, but in cognitively efficient ways, and another is to retain knowledge in such way as to support a coherent and effective self. Conway, Meares et al. (2004) propose that this is achieved by what they term adaptive coherence. That is to say that there is some optimum level of retention for any given experience that maximizes fitness and survival. For instance, for many experiences simply recalling the meaning or the 'gist' may be sufficient, as Bartlett (1932) so strongly argued, (see Brainerd & Reyna, 2001, 2004; Koriat, Goldsmith, & Pansky, 2000, for recent treatments of this and see too Neisser's, 1981 classic study of John Dean's memory). In autobiographical remembering there is a great deal that people can accurately remember, i.e., that certain events occurred, without recalling many or, in some instances, any further details. Note that, this is not to do with inferring what must have taken place or what might have been the case. But rather it is to do with representing experience conceptually. In unpublished work from our laboratory we have found that people can remember experiences as varied as period of work, a holiday, period of illness, house they once lived in, people that they have briefly met, etc., without being able to recall any, or more than a few, specific memories. Retention of conceptual autobiographical knowledge that corresponds to experiences that actually occurred without access to associated episodic memories may be one way the SMS reduces the potential information overload of retaining very detailed and extensive records of experience. Conceptual autobiographical knowledge and retaining the meanings of experiences are ways in which memory can accurately correspond to experience in efficient ways. Overall, a central principle of the SMS framework is that memory is a product of the tradeoff between the separate but competing demands of coherence and correspondence.

Recent memory and long-term memory

A fundamental problem confronting any goal-based system is how to keep track of progress in goal processing. If you cannot remember whether or not you locked the door of your house this morning the only way to evaluate this goal is to conduct some sort of physical check. But the cost in activity and time of such checking are prohibitive and can be maladaptive. Consider the extreme case of the densely amnesic patient Clive Wearing (Wilson, Baddeley, & Kapur, 1995) who initially kept several diaries in which, every few minutes, he would write that he had just awoken from being dead, apparently unaware that he had written the same statement a few minutes earlier. Although this patient is unusual it is the case that many patients with anterograde amnesia repeat actions, statements, and behaviors that they fail to remember having recently executed. Set against this is a storage-cost problem. An efficient memory system could not retain the many thousands of memories of door locking, car parking, and all the myriad's of routine every day activities. Despite this, memories of such events must initially be formed otherwise progress in goal processing could not be accurately tracked. Perhaps, these recent memories are, within a short period of time, actively inhibited (Bjork, 1989) and because of this they are not rehearsed and so rapidly become difficult to access. Such memories might still, perhaps, play some nonconscious role and for at least some time continue to influence cognition implicitly.[2] The suggestion that episodic memories arising from everyday experience may have enduring nonconscious effects is particularly interesting and points to a new and potentially important direction for future autobiographical memory research.

The SMS framework proposes that all recent memories are ultimately on a forgetting trajectory and will in fact be forgotten unless they become integrated with other long-term memory representations. From an adaptive point of view this is desirable because a record of events that featured recent goal processing is retained but for only a brief period and, therefore, does not impose an unacceptable demand on storage. Long-term memory does not retain extensive numbers of recent memories. Instead, it is proposed that, retention of recent memories only occurs for those recent episodic memories associated in some way with long-term goals. In summary, recent memory consists of a set of recently formed episodic memories that represent events

[2] I am grateful to Professor Larry Jacoby, of Washington University, for drawing this possibility to my attention.

featuring short-term goal-processing, e.g., getting to work. Long-term memory contains knowledge and episodic memories related to long-term goal processing, e.g., completing a work project. In terms of correspondence and coherence, recent memory is biased towards correspondence at the expense of coherence whereas the reverse is the case for long-term memory which is biased towards issues of coherence over correspondence. In the sections that follow a wide range of findings that bear upon these distinctions are described.

The working self

In the SMS framework recent episodic memory and long-term autobiographical knowledge solve the problems of keeping track of short- and long-term goal processing respectively. Another set of problems, however, relate to goal management, i.e., coordinating goal processing, maintaining goal compatibility, goal prioritization, etc. This is achieved by the working self, the main function of which is to maintain coherence (between goals) and it does so, in part, by modulating the construction of specific memories, determining their accessibility and inaccessibility, and in the encoding and consolidation of memories.

Goals and self-knowledge

The term working self as used by Conway and Pleydell-Pearce (2000) refers to the currently active goal hierarchy which they viewed as part of the working memory system (Baddeley, 1986, 2000). The central idea is that there is a highly complex goal-sub-goal hierarchy of interlocked negative and positive feedback loops in which goals are represented at different levels of specificity (Carver & Scheier, 1982, 1998). The purpose of the goal hierarchy is to reduce discrepancies between desired goal states and the current state and in so doing, regulate behavior. It is through the goal hierarchy that new knowledge enters long-term memory and it is also through the working self that preexisting knowledge is accessed and memories are constructed. It is proposed that the goal structure is in a permanent state of activation but at any given time some subset of the structure is at a yet higher level of activation and is operative in guiding and regulating current cognition, affect, and behavior (see Carver & Scheier, 1998). In these respects, the goal hierarchy of the working self-operates as a set of control processes that determine encoding, accessibility of knowledge in long-term memory, and the construction of memories (see Burgess & Shallice, 1996; for a more processing-oriented account of the working self, Markus & Ruvolo, 1989; for a more social-cognitive oriented account, and the closing section of this paper for data on the neurological representation of this system).

A recent theoretical development of the working self-construct (Conway, Meares et al., 2004), one that aimed to integrate the SMS model more fully with social-cognitive theorizing about the self, e.g., Cantor and Kihlstrom (1985, 1987, 1989), Klein and Loftus (1993), Neisser, 1988, recognizes that in addition to the working self-goal structure there is also a set of working self-conceptual knowledge. This consists of non-temporally specified conceptual self-structures, such as personal scripts (Demorest, 1995; Singer & Salovey, 1993; Thorne, 1995; Tomkins, 1979), possible selves (Markus & Nurius, 1986), self-with-other units (Ogilvie & Rose, 1995), conceptual aspects of internal working models (Bowlby, 1969/1982, 1973, 1980), relational schema (Baldwin, 1992), self-guides (Strauman, 1990; Strauman & Higgins, 1987), attitudes, values and beliefs. All of these are abstracted knowledge structures that exist independently of specific temporally defined incidents (episodic memories and autobiographical knowledge), but are connected to autobiographical knowledge and the episodic memory system to activate specific instances that exemplify, contextualize, and ground their underlying themes or concepts. Conway, Meares et al. (2004) term this the conceptual self. The representations of the conceptual self are socially constructed schema and categories that define the self, other people, and typical interactions with others and the surrounding world. These schema and categories are drawn largely from the influences of familial and peer socialization, schooling, and religion, as well as the stories, fairy-tales, myths, and media influences that are constitutive of an individual's particular culture (Bruner, 1990; Pasupathi, 2001; Shweder & Bourne, 1984). Thus, both goals and conceptual self-knowledge act as control processes or as the source for such processes in the everyday regulation of memory.

Maintaining coherence

Recently, Conway, Meares et al. (2004) and Conway, Meares, and Standart (2006) have suggested that at the heart of the working self-goal structure is a principle of conservatism, the purpose of which is to resist goal change (in this respect the working self corresponds to what Greenwald, 1980; called the 'totalitarian ego'). Goal change is costly in cognitive-affective terms because any change, even the successful achievement of a goal, has consequences for many other goals. Moreover, during a period of goal-change the self may be more vulnerable to destabilizing influences and less capable of operating effectively upon the world. Thus, the working self may act to lower the accessibility of memories of events which challenged the goal structure. It may even distort memories of such events in order to maintain coherence and to delay or avoid altogether goal-change, cf. Wilson and Ross (2003). Conway, Meares et al. (2004) provide

several clinical examples of patients with posttraumatic stress disorder (PTSD) who presented with intrusive vivid memories that contained errors or which were false. These PTSD memories appeared to serve a defensive function which was to protect the self from major change. One of the most common comments from trauma survivors is that post trauma they are a "different person," which at least suggests that changes to the self following the experience of trauma can be far reaching (see Conway, Meares et al., 2004, 2006 & Conway, Singer et al., 2004, for a more detailed treatment of this point). By way of illustration consider the following two cases:

(i) Memory for a road traffic accident (RTA). A man who drove cars for a living was involved in a road traffic accident. He was a back seat passenger in a car when it was in a high speed collision with another vehicle; activation of the air bags in the front of the car produced a cloud of powder, which he thought at the time was smoke. At the time he could smell petrol and thought the car might ignite and he remembered thinking 'I will be burned alive.' His wife was unconscious after the impact and he thought that she had died. He remembered thinking to himself 'What am I going to do now?' as he thought about his future alone without his wife. Subsequently he experienced severe guilt about this thought, which suggested to him that he was a selfish person. It became one of his intrusive flashbacks and always induced an overwhelming guilt. In addition, he was a highly professional driver and he had anticipated the crash, but did not cry out. He felt that he could have averted the crash if he had done so. He experienced intrusive thoughts, such as 'I should have shouted' (to warn the driver) and he relived the feeling of guilt he felt when he thought his wife had died, which he believed to be his fault because he did not shout a warning.

(ii) A 9/11 eyewitness. A middle-aged woman observed the planes going into the World Trade Center from a street close by. Two months later she was referred to a cognitive behavioral therapy (CBT) clinic (in England) and appeared to be very distressed, anxious, and with marked avoidance. She had a powerful distorted visual image flashback in which she saw herself high above the ground observing the collision of the plane with the building. The scene is very peaceful and there is no noise. Whenever the image intruded into consciousness, which it frequently did, she felt intense, destabilizing, guilt.

These examples are interesting for several reasons. But note that for the 9/11 witness her memory is clearly false and she was able to recognize it as false, even though she nonetheless experienced it as a 'real' memory. A later section considers how it is possible to have memories that are false or not even memories but nonetheless experience these mental states as memories. Note too, the strong parallel with findings from the laboratory using the DRM procedure which induces recollective experience for items falsely recognized (Roediger & McDermott, 1995). Both patients underwent cognitive behavioral therapy (CBT) in which 'reliving' was a prominent part of the treatment. For the RTA patient this entailed a visit to the crash site, detailed examination of police records, as well repeated recall of all that could be remembered of the experience. For the 9/11 patient the treatment focussed on imagery and in trying to reinstate something close to the perspective she would have had at the time (rather than the 'observer' perspective of her flashback, see Nigro & Neisser, 1983). A breakthrough in the treatment of the RTA patient occurred when he realized, based on police records and his own memory, that there had in fact been no possibility of him shouting a warning. In his memory the moment of impact was time dilated so it appeared to him that he had the opportunity to shout a warning, but for some inexplicable and 'guilty' reason had not. In CBT the time dilation gradually diminished so that his memory came to represent more accurately the speed with which the collision had occurred. As this change in his memory came about so his intrusions diminished and the guilt and anxiety associated with them considerably weakened. The 9/11 patient quite quickly regained a field perspective in her memory and could then recall the cries of the crowd around her as she looked up to see the plane strike the building. At this point she was able to experience the powerful feelings of foreboding, fear, and anger which she had experience at the time, but which up to this point she had not been able to either experience or acknowledge. Once the observer perspective was reinstated her PTSD symptoms lessened, eventually being lost altogether (Conway, Meares, et al., 2006, for a full account of these and several similar cases).

According to the present view of autobiographical memory the SMS operates to protect itself from change (to maintain coherence). In the case of the RTA patient, although he eventually resumed a normal life he did not return to his career of professional driving. Indeed, he required further therapy to enable him to even sit in a car. For this patient the accident clearly demonstrated to him that he was not always in total control when driving a vehicle, that events could occur no matter how professional a driver he was. This notion was destabilizing for the patient to such an extent that it was preferable to have a distorted intrusive memory than to acknowledge it and its implications. During his CBT issues of control emerged as a preoccupation in several areas of

his life and his choice of career, driving, was an important realization of one of his central motivations: to have control. The only way he could accept the clear meaning of the RTA, that he did not always have control, was to instigate major changes to his goal system. It is not suggested that any of this occurred consciously but rather that working self-control processes distorted the memory to maintain the belief of control, i.e., that he could have shouted a warning when in fact there was no time to do so. The distortion maintained the illusion of control but only at the cost of psychological illness. The observer perspective (Nigro & Neisser, 1983) in the false memory of the 9/11 witness was clearly an attempt to avoid recalling a very difficult memory, an attempt to avoid acknowledging the human aspect of the attack and her own intensely negative emotions. Cognitive behavioral therapy for her focussed strongly on this avoidance (of her emotions). In her case it was preferable for the SMS to have a distorted and false memory than to remember her emotional reactions to the attack. She eventually recovered and returned to New York to meet relatives of some of the victims. Interestingly, as she recovered she too changed her career, and in this respect became a 'new' self.

Conway, Meares et al. (2004, 2006) describe a range of other cases in which memory distortions in PTSD appeared to serve a protective function (against goal-change). There is, however, no suggestion that this always occurs in PTSD or even that it is very frequent. From the current perspective it is mainly of interest because it demonstrates that distortions of memory in the SMS can and do occur, and when they do they are often attempts to avoid change to the self, and ultimately to goals. In other words, they are attempts to maintain coherence during traumatic experiences that overwhelm the self, when an individual might experience 'mental defeat' (Ehlers & Clark, 2000) or the complete failure of the goal-system to operate effectively during the trauma. What is also of interest is that the patients in all the cases described by Conway, Meares, et al. (2006), were able to regain access to more accurate memories of their trauma experience. This is by no means always the case (see, for example, the cases reported in Ehlers, Hackmann, & Michael, 2004) and in other memory disorders in which confabulation features, false memories may be persistent and pervasive.

Conway and Tacchi (1996), reported a detailed case study of an RTA victim (patient OP) who sustained frontal lobe damage and subsequently developed a range of false autobiographical memories that portrayed her current situation as far more supportive than it in fact was. Pleasant wishful false memories that can arise following frontal injuries often seem to serve the function of maintaining a positive view of current circumstances, cf. Fotopoulou, Solms, and Turnbull (2004). These frequently are unrealistically positive and may feature implausible events, denial of physical incapacities, and lack of insight into their brain damage (anosognosia). In contrast, other types of frontal damage (often mainly to the right hemisphere) can give rise to false memories that support an aggressive and paranoid view of the world (Fotopoulou & Conway, 2004). Fotopoulou, Conway, Solms, Griffiths, and Tyrer (2006) report the case of patient AO who suffered extensive right hemisphere lesions and subsequently developed many paranoid false memories and beliefs, i.e., that she was moved from room to room at night, that she had rows with carers, etc. These were persistent and often consistent. Fotopoulou et al. (2006) argue that these false memories were generated by the SMS to justify her feelings of paranoia and anger. Patient AO was anosognosic for her physical and mental incapacities. For example, she not only claimed she could walk but confabulated memories of recent trips in which she walked long distances (around her childhood village in Scotland for example which was over 250 miles away and impossible for her to visit). She blamed the doctors for doing something, nonspecific, to her head. Occasionally, AO did have insight into her condition and could acknowledge her injuries. But these insights were rare episodes and quickly supplanted by the return of her paranoid confabulations, the ultimate function of which was to deny her changed state of well-being and the major changes to her goal-system that this required.

According to the SMS framework control process of the working self may act to edit memory content or generate false memories to resist change and, ultimately, to maintain goal coherence. This is seen strikingly in some patients with psychological illnesses and in other patients with brain damage. It may, however, be a general feature of all autobiographical remembering and, perhaps, one of the reasons that memory has been found to be so open to manipulations that create false memories or which distort features of existing memories (see Conway, 1997a, 1997b; Loftus & Ketcham, 1994; Schacter, 1997). An interesting corollary is that it should be difficult if not impossible to induce false memories and memory distortions which disrupt coherence. It is notable that the types of memories that have been induced using experimental procedures are of fairly anodyne and plausible childhood events such as being lost in a shopping mall (Loftus & Ketcham, 1994) or spilling a soup turin at a wedding reception (Hyman, Husband, & Billings, 1995). These are memories that hardly conflict with goals and beliefs about the self. The SMS view predicts that experimentally inducing false memories that undermine currently active goals is most probably not possible (in healthy individuals).

Finally, in this section it might be noted that it is not suggested that maintaining coherence is the only way in which memory distortions and errors can arise. Arguably, one of the major generators of these sorts of

memory failures (or failures of correspondence) are errors in source monitoring (Johnson, Hashtroudi, & Lindsay, 1993; Johnson, Hayes, D'Esposito, & Raye, 2000). Correctly establishing the nature of an activated mental representation by identifying its source may be one of the control processes that enable the working self to appropriately coordinate processing sequences. In the case of confabulating frontal patients it is clear that source monitoring errors are an important factor underlying their false memories. Take the case of AO above, one of whose sets of confabulated memories was that nurses ('evil' nurses according to AO) often woke her during the night and made her move from her room. (An experience which could occur several times a night.) Indeed, this was one of the confabulations that she often presented with at the beginning of a testing session. However, it is well known that frontal patients have disrupted sleep cycles and AO would certainly have spontaneously awoken most nights, usually several times. It is also probable that she suffered from some paramnesia and may well have believed herself to have awoken in another room than the one she went to sleep in. If this were the case then the source monitoring error would be to confuse her thoughts with actual experience. Fotopoulou and Conway (2005) found that AO often had recollective experience (see the section on episodic memory ahead) for her confabulations which she experienced as memories. Thus, source monitoring errors almost certainly would have played a role in AO's confabulations. It is possible that mistaking thoughts and fantasies for memories, even experiencing them as memories, may be quite common in patients with disrupted control processes. The point is that such source monitoring errors can be used by the working self to protect against the need for goal change and to maintain coherence. For both OP and AO confabulated memories, of quite different types, served the very useful purpose of avoiding consciously recognizing an unpleasant reality and the need to change to deal with exigencies of that reality. Experiencing one's fantasies as memories is clearly maladaptive but it may nonetheless constitute an effective working self-strategy for maintaining coherence.

Memory accessibility

The working self moderates between the demands of coherence and correspondence in the formation of memories and in their construction. According to the SMS view, however, issues relating to coherence predominate in long-term memory and in order to maintain coherence between memories, conceptual knowledge, goals and the conceptual self, control processes of the working self-modulate the accessibility of autobiographical knowledge and episodic memories. It does so to ground the self in memories of goal-relevant self-defining experiences (Pillemer, 1998; Singer & Salovey, 1993; Singer, 1995) that provide constraints on what the self has been, can currently be, and what it might become in the future. (See Tulving, 2002, for a related and particularly interesting account of the subjective sense of time or as he terms it, chronesthesia.) Singer and Salovey (1993) found 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 has a set of 'self-defining' memories which contain critical knowledge of progress on the attainment of long-term goals, e.g., attaining independence, intimacy, mastery, and so on. The pattern of highly accessible memories provides the major active content of the self and it is from this knowledge that 'self-images' emerge. Self-images are mental models (Johnson-Laird, 1983) of the self in relation to past, current, and future goals and form part of the conceptual self as discussed earlier. For example, one of the existential problems that faces the adolescent is how to integrate an emerging self with larger social groups, culture, and society generally (Erikson, 1950/1997); also known as the problem of the formation of a *generation identity*, (Conway, 1997a, 1997b, see too the brilliant original essay on this concept by Mannheim, 1952). Holmes and Conway (1999) and Conway and Holmes (2004) found that autobiographical memories from this period, as recalled by middle-aged and older adults, often featured either learning about events of major public importance or attending and taking part in cultural events. Recall of autobiographical memories of public and cultural events from other periods of life was less common. Thus, there may be a set of self-images relating to the late period of adolescence that provide access to memories of public and cultural events and in this way integrate the self with generation-defining events.

This type of raised accessibility of memories of events once high in self-relevance, because of their self-defining properties, can in fact be seen across the lifespan. Conway and Holmes (2004) had older adults (70+ years) free recall memories from each decade of their life. The memories were then content analyzed on the basis of Erikson's (1950/1997) characterization of each of the psychosocial stages proposed to occur across the lifespan. Of especial interest here was the distribution of memories, by age at encoding, across the lifespan. Fig. 1 shows the distribution by age at encoding of memories classified as being dominated by content related to the psychosocial stages of childhood psychosocial themes, identity/identity confusion (adolescence), intimacy/isolation (young adulthood, early 20s), and generativity/stagnation (middle age). It can be seen from Fig. 1 that those memories classified as being strongly related to a particular psychosocial stage tend to predominate at the point in the

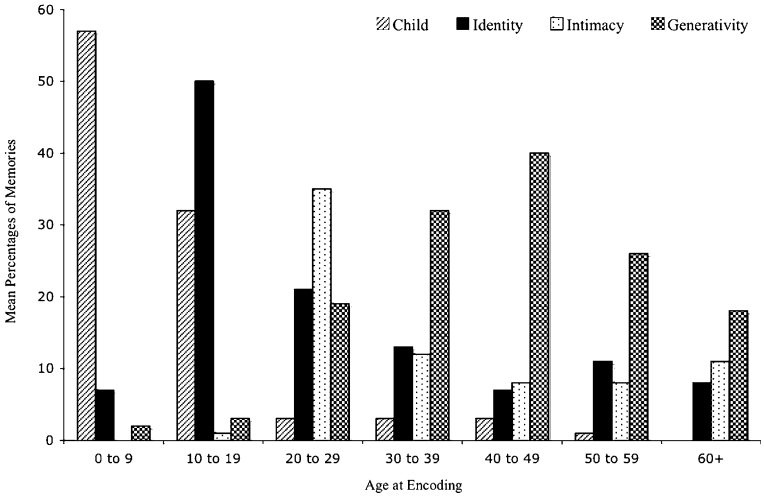

Fig. 1. Distributions of memories across the lifespan by psychosocial theme.

lifespan when the stage would have been dominant. This is not an all-or-none effect but rather one of degree as at any given psychosocial stage memories relating to a variety of psychosocial themes are present. This, and other findings from Conway and Holmes (2004), suggest that memories of events that were once of high relevance to the self remain in a state of high accessibility and are amongst the first memories to come to mind when a period in the past is freely sampled. It seems that memories of experiences that have been of strong life-goal significance remain strongly associated with the self and its history. This is the case even after the period in which the specific goals featured has passed, and been replaced by sets of goals active in the current psychosocial period.

Although generation identity may be an important aspect of the development of the self in late adolescence, other themes and goals are also significant. The development of close and intimate relationships in late adolescence and early adulthood is one. Investigating this Thorne (1995) found that the content of memories freely recalled across the lifespan by 20-year-olds conformed to what she termed 'developmental truths.' Memories from childhood very frequently referred to situations in which the child wanted help, approval and love, usually from parents, whereas memories from late adolescence and early adulthood referred to events in which the rememberer wanted reciprocal love, was assertive, or helped another. More recently, McLean and Thorne (2003) focused on the content of 19-year olds' self-defining memories of relationship experiences. They found that memories of parents tended to emphasize issues relating to separation whereas self-defining memories of peers emphasized closeness and romantic relationships. Thus, memories of adolescence are often of events in which identity formation is preeminent, either at the group or societal level or in individual personal relationships. Such memories clearly relate to the pursuance of important goals that mark the emergence of an independent self-system in late adolescence. Assuming that the goals which preoccupy the individual at his point do not change in kind, then the memories that ground them in remembered reality should remain highly accessible across the lifespan.

These periods of development of the self are reflected in the life span retrieval curve which is observed when older adults (about 35 years and older) recall autobiographical memories in free recall or in a variety of cued recall conditions (Franklin & Holding, 1977; Fitzgerald & Lawrence, 1984; Rubin, Rahhal, & Poon, 1998). Memories are plotted in terms of age at encoding of the remembered experiences and the resulting life span retrieval curve typically takes a form similar to that shown in Fig. 2 (this is an idealized representation derived from many studies and not based on specific data).

As Fig. 2 shows the life span retrieval curve consists of three components: the period of childhood amnesia, (from birth to approximately five years of age), the period of the reminiscence bump (from 10 to 30 years), and the period of recency (from the present declining back to the period of the reminiscence bump). The pattern of the lifespan retrieval curved is extremely robust and has been observed in many studies, to such an extent it led Rubin to conclude that it was one of the most reliable phenomena of contemporary memory research (Conway & Rubin, 1993). This reliability is remarkably striking and in a recent study we (Conway, Wang, Hanyu, & Haque, 2006) sampled groups from five different countries: the US, UK, Bangladesh, Japan, and China. Fig. 3 shows the lifespan curves for each of these countries. Note, that participants although asked to free recall 20 memories from their life were additionally

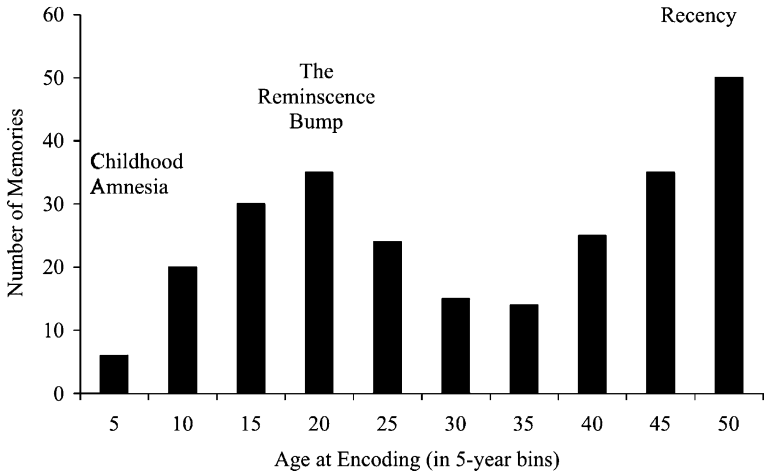

Fig. 2. Idealized representation of the lifespan retrieval curve.

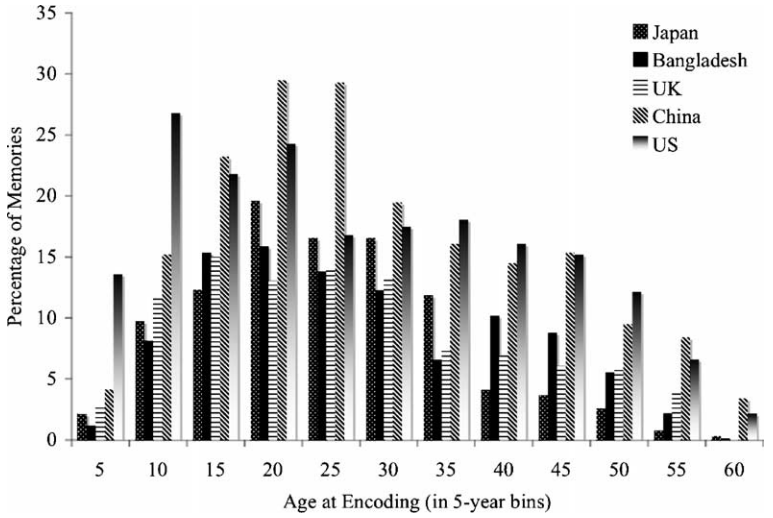

Fig. 3. Lifespan retrieval curves for six countries.

instructed not to recall events from the previous year (to eliminate the recency portion of the curve).

It can be seen from Fig. 3 that there were striking periods of childhood amnesia and the reminiscence bump across countries and these were statistically reliable. Moreover, there were no reliable differences between countries other than the US cohort who had earlier earliest memories than all other countries. This further attests to the robustness of the lifespan retrieval curve, indeed even perhaps to its universality. It was nonetheless an unexpected finding and is returned to below.

Childhood amnesia

There are many theoretical explanations of the period of childhood amnesia (see Pillemer & White, 1989 & Wang, 2003 for reviews) but most flounder on the fact that children below the age of 5 years have a wide range of specific and detailed autobiographical memories (Bauer, 1997; Fivush, Haden, & Reese, 1996). Explanations that postulate childhood amnesia to be related to general developmental changes in intellect, language, emotion, etc., fail simply because apparently normal autobiographical memories were in fact accessible when the individual was in the period of childhood amnesia. It seems unlikely that an increase in general functioning would make unavailable already accessible memories. From the SMS perspective this period is seen as reflecting changes in the working self-goal hierarchy. The goals of the infant and young child, through which experience is encoded into memory, are so different, so disjunct, from those of the adult that the adult working self is

unable to access those memories (see too Howe & Courage, 1997, for a particularly interesting account of childhood amnesia in terms of development of the self). Other accounts emphasize mother/child interactions, the role of language development, and emergence of narrative abilities (Nelson & Fivush, 2004).

Socialization and culture must play some role in the development of memory, although it seems that the infant/child capacity to actually have episodic memories may predate these developments (Rovee-Collier, 1997). If this is the case then presumably the effects of socialization, culture, and language are largely on the organization of memory and perhaps on memory content too, rather than on the processes that mediate the actual formation of episodic memories. For instance, the finding mentioned earlier of Conway, Wang et al. (2006) in which US participants were found to have earlier 'earliest' memories than all other groups might relate to the observation that US mothers undertake more 'memory' talk with their children than mothers from other countries. Moreover, Wang (2001) have found powerful cross-cultural differences in the focus and content of memories. Childhood memories from people in cultures with interdependent self-focus (Markus & Kitayama, 1991), China, for example, tend to be less oriented to the individual, less emotional, and more socially oriented than the childhood memories of people from cultures with independent self-focus, Northern Europe, North America, for example. Fig. 4 shows data from Wang (2001) on this.

Thus, socialization experiences and the self-focus that predominates in a culture may influence the accessibility of earliest memories and their content. Despite this it may still be the case that these influences act upon an emerging SMS in which sensory-perceptual episodic memories already exist. These are difficult issues to investigate, particularly in the laboratory, and recently we (Morrison & Conway, 2006) have been attempting to explore the question of the relationship of language to early memories by having adult participants recall their very earliest memory to individual words in a set of cue words. A novel feature of this procedure is that mean age-of-acquisition (AoA) of the cue words is known and, therefore, the age-of-encoding (AoE) of the earliest memory retrievable to a word can be compared to AoA. If there is some systematic relationship between language and emergence of autobiographical memory then that may be evident in the relation of AoA and AoE. In two studies using a large group of cue words that varied in AoA we found positive correlations of $r = 0.85$ and $r = 0.8$, respectively, and for both $p < .001$, demonstrating a very strong relation between AoA of cue words and AoE of earliest memories. Interestingly however, AoA differed from AoE by being, on average, 10 months earlier. Moreover, these earliest memories date to when the participants were aged between 5 and 7 years and, therefore, to a period which is considerably later than that of the very earliest memories, which typically date to about 3–4 years of age (see Fig. 2). These data suggest that children have to learn to apply words to experiences they are in process of encoding or have already encoded prior to acquiring particular words. The data indicate that this occurs about 10 months after acquiring a word and in a period when it is known that children already have many memories. Thus, memories predate acquisition of words with which

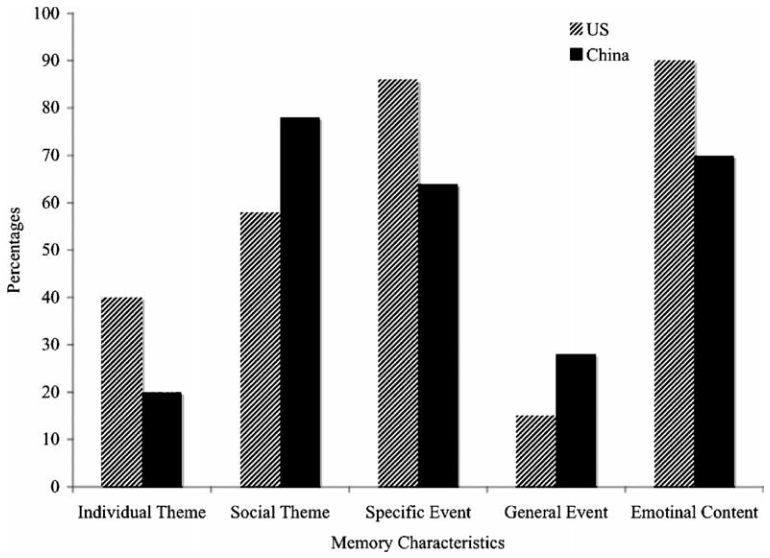

Fig. 4. Differences between Asian and North American autobiographical memories.

they might be associated but once words have been acquired and associated with memories a consistent and systematic relation is present. Another important determinant of the accessibility of earliest memories may then be the age at which a memory or feature of a memory can be described with language and associated with specific words. A clear implication of this is that the relatively slow development of associations between words and memories might be an additional factor contributing to the inaccessibility of childhood memories in adulthood.

The reminiscence bump

The second component of the lifespan retrieval curve is the period when rememberers were aged 10–30 years and this is known as the reminiscence bump (Rubin et al., 1998). The reminiscence bump is distinguished by an increase in recall of memories relative to the periods that precede it and follow it. The reminiscence bump is present not just in the recall of specific autobiographical memories but also emerges in a range of different types of autobiographical knowledge. For example, the reminiscence bump has been observed in the recall of films (Sehulster, 1996), music (cf. Rubin et al., 1998), books (Larsen, 1998), and public events (Holmes & Conway, 1999; Schuman, Belli, & Bischoping, 1997). Memories recalled from the period of the reminiscence bump are more accurate (Rubin et al., 1998), they are judged more important than memories from other time periods, and are rated as highly likely to be included in one's autobiography (Fitzgerald, 1988, 1996; Fromholt & Larsen, 1991, 1992; Rubin & Schulkind, 1997). The reminiscence bump is only observed in people over the age of about 35 years and some recent findings suggest that it might only be present, or is much more prominent, in memories of positive experiences (Rubin & Berntsen, 2003).

Many of the more obvious explanations of the reminiscence bump have been rejected, i.e., that the memories are of first time experiences and that is why they are memorable, but in fact it has been found that less than 20% are typically of first time experiences (Fitzgerald, 1988). Rubin et al. (1998) reviewed a series of potential explanations and argued in favor of an explanation in terms of novelty. According to this view the period when people are aged 10–30 years, and especially 15–25 years, is distinguished by novel experiences, occurring during a period of rapid change that gives way to a period of stability. It is assumed that memories from the period of rapid change are more distinct than those from the period of stability and this is why they are comparatively more frequently accessed. By this account a period of rapid change taking place at some other point in the life cycle should also lead to raised accessibility of memories from that period relative to more stable periods and there is some evidence that this is the case (Conway & Haque, 1999). However, periods of (goal) change and experiences of novelty always involve the self and a related but alternative explanation is that the high accessibility of memories from this period (and other periods too) may be related to their enduring relation to the self (Conway & Pleydell-Pearce, 2000). Possibly, many memories from the period of the reminiscence bump are memories of "self-defining" experiences (Fitzgerald, 1988; Singer & Salovey, 1993) and have a powerful effect in cohering the working to self into a particular form. The novelty of reminiscence bump experiences lies in their newness and uniqueness for the self and they may play a crucial role in the final formation of a stable self-system and identity formation during late adolescence and early adulthood. The raised accessibility of these memories might then serve processes relating to coherence and the duration of a coherent self through time.

One final explanation, considered but rejected by Rubin et al. (1998), argues that there may be something special about memory during the period of the reminiscence bump. The suggestion is that encoding is, somehow, more efficient during this period and it is this that gives memories formed during this period an advantage in accessibility: they stand out in memory by virtue of some differential from of encoding. Note that, this is a type of correspondence theory related in kind to Brown and Kulik's (1977) encoding account of the formation of flashbulb memories (see Conway, 1995, for a review). A correspondence theory like this might, perhaps, posit that hippocampal networks function more effectively during this period or maybe fronto-hippocampal interactions are more efficient so that information is encoded is some unusually highly accessible form. Given that there are no reasons other than the phenomenon of the reminiscence bump itself to support an encoding or special processing account it seems implausible as an explanation of the reminiscence bump, as, indeed, Rubin et al. (1998) concluded. However, the findings of Conway et al. (see Fig. 3 above) suggest that this rejection may be premature. The cross-cultural finding of a highly similar reminiscence bump in all six countries sampled was unexpected. The original hypothesis had been that cultures with interdependent self-focus (Markus & Kitayama, 1991), China for example, would have a reminiscence bump dating to a later period (20–40 years of age rather than 10–30 years of age). This is because in these cultures coming of age occurs later than in the individual-focussed cultures of Europe and North America. In China, a young man becomes an adult when he has developed a certain group of colleagues and friends and a young woman an adult woman when she has her first child. Typically, people are aged about 30 years when this occurs compared to a coming of age in the late adolescence in cultures with an independent self-focus. The reminiscence bump was, however, quite

independent of these potential effects of culture and that at least suggests that a pan-cultural explanation may be required. Such an explanation might well be based on the suggestion of development of neural processes in late adolescence.

Memory inaccessibility

In the SMS framework then, one of the important functions of the working self is to raise the accessibility of memories of experiences in which important goal related processing occurred. These memories are often of self-defining experiences from critical periods of the formation of the self and other highly self-relevant memories of experiences which featured the processing of dominant goals. The working self, however, also acts to lower the accessibility of memories of experiences that threaten and undermine the coherence of the self-system or which require major change if they are to be accommodated by the SMS. This is especially so for those memories that contradict the goals of the working self and important conceptual aspects of the self, e.g., self-images. One way in which this might be accomplished is by inhibitory control of autobiographical remembering and several recent projects have attempted to examine this using standard laboratory procedures (for reviews of these procedures see, Anderson, 2003; Bjork, 1989 Bjork, Bjork, & Anderson, 1998). In a series of directed forgetting experiments we examined the sensitivity of recently recalled autobiographical memories to an explicit instruction to forget (Barnier, Conway, Mayoh, Speyer, & Avizmil, 2006; Conway & Barnier, 2003). In these experiments, participants were presented with cue words and to each word they recalled a specific autobiographical memory (Conway & Bekerian, 1987a; Crovitz & Schiffman, 1974; Robinson, 1976). They were instructed to try to keep both cue words and the memories they recalled in mind for a later memory test. At the the midpoint of the list half the participants (the F-group) were informed that they had just completed a practice list. This list (List 1) was to familiarize them with the procedure and the types of cues to be used and they should now forget the practice list and the memories recalled up to this point and concentrate instead on the upcoming experimental list (List 2) for which they would be required to recall cues and associated memories. Other participants (the R-group) were informed that they had now studied the first part of the list, and they should try to retain both the cues and associated memories, while they recalled further memories to the second part of the list, for which their memory would also be tested. Each list consisted of 12 words in three groups of four positive words, e.g., happy, summer, etc., four neutral words, e.g., chair, kitchen, etc., and four negative words, e.g., accident, illness, etc. Order of presentation of words was random. Over five experiments there were two persistent findings: a powerful and statistically reliable overall directed forgetting effect but one that was only consistently reliable for positive and neutral cue words. The means in Table 1 show this over the full five experiments. Thus, negative memories appeared more resistant to directed forgetting than other types of memories.

Inhibitory control of recently recalled autobiographical memories is then possible using a simple single-episode intentional laboratory procedure. In everyday cognition using a similar procedure perhaps hundreds or even thousands of times, even to the extent that it becomes automated for the to-be-forgotten memories, might be a powerful way to control memory accessibility: indeed it may even extend to memories of negative experiences. Another way in which inhibitory control might be achieved is by selective rehearsal of memories or parts of memories. Barnier, Hung, and Conway (2002) investigated this using a modification of the retrieval practice procedure (cf. Anderson & Spellman, 1995). In this procedure participants recall memories to cue words from happy, sad, angry, and friendly categories. For each memory they provide a short title. They then practice recalling the memory they recalled earlier to cues taken from any two of the categories (this is cycled over participants so that all categories are equally sampled). After a 10-min delay they receive a category cued recall test in which they recall the memories they recalled earlier to each of the cue words. This procedure yields three types of memory items: items which have been practiced, rp+, items from practiced categories which were not themselves practiced, rp− items, and items which were neither practiced nor originate from practiced categories, nrp items. The typical finding is that rp+ items are recalled to a high level, nrp items to an intermediate level and rp− items to level reliably

Table 1
Directed forgetting of recently recalled autobiographical memories

Group	Cue valence					
	Negative		Positive		Neutral	
	List 1	List 2	List 1	List 2	List 1	List 2
Experiment 1						
Forget	0.54	0.71	0.35[a]	0.72	0.36[a]	0.59
Remember	0.52	0.71	0.58	0.54	0.53	0.48
Experiment 2						
Forget	0.50	0.68	0.38[a]	0.65	0.39[a]	0.53
Remember	0.59	0.58	0.53	0.60	0.53	0.48

[a] List 1 recall in the Forget group that is significantly lower than List 1 recall in the Remember group, whereas List 2 recall in the Forget group is significantly higher than List 2 recall in the Remember group. Showing a strong directed forgetting effect.

Table 2
Inhibition of recently recalled autobiographical memories in the retrieval practice procedure

	Cue valence		
	Negative	Positive	Neutral
Rp+	0.85	0.84	0.97
Rp−	0.67[a]	0.48[a]	0.78[a]
Nrp	0.79	0.66	0.83

[a] Recall levels that are significantly lower than Nrp recall. Rp+ = practiced items, Rp− = items from practiced categories which were not themselves practiced, Nrp = items from unpractised categories.

lower than that of nrp items, showing inhibition of these items. Barnier et al. (2002) found exactly this pattern for recently recalled autobiographical memories and Table 2 shows mean recall. Note that, unlike directed forgetting the inhibitory pattern is present for all types of emotional memories including memories of negative experiences demonstrating that memories of these experiences can be impaired too, and by a relatively simple laboratory task. Note that both sets of findings are laboratory demonstrations of inhibition of recently recalled items. Our view is that in everyday cognition procedures like directed forgetting and retrieval practice may be spontaneously and repeatedly used to avoid conscious awareness of certain memories and thoughts. The fact that this can be induced in the laboratory at all is some indication that this at least could occur in other settings.

It is worth noting that there are several differences between directed forgetting and retrieval practice. Obviously in the former the forgetting is intentional whereas in the later it is not. But perhaps more important is that in retrieval practice, practice is repeated (three times per rp+ item in Barnier et al., 2002) thereby providing several opportunities to trigger inhibition of associated (rp−) items. Possibly, it is this repeated inhibition that leads to successful inhibition of all types of recently recalled memories including negative autobiographical memories. Set against this, however, we have found that repeatedly practicing not thinking about recently recalled autobiographical memories (positive, negative, and neutral) does not impair their recall (Barnier, Racsmany, & Conway, 2006). Instead the pattern of findings in the directed forgetting and retrieval induced forgetting for recently recalled autobiographical memories suggests that competition between memories, for later recall, might be an important factor in triggering inhibition. Indeed, Barnier et al. (2006) found that memories from the same time period, e.g., a holiday, showed strong effects of directed forgetting whereas memories from a less distinct more disparate period did not. As the next section shows autobiographical memory is highly organized into relatively discrete sets of knowledge, potentially making it particularly sensitive to inhibition triggered by competition. This suggests the following explanation of the two sets of findings: the directed forgetting experiments induced only weak competition and this was not sufficient to cause the inhibition of negative memories. Perhaps, the negative affect associated with such memories requires more extensive inhibition that the mild affect induced by positive and neutral experiences. The retrieval practice experiments were more effective in inducing inhibition and this may be because the retrieval practice procedure causes stronger and more direct competition between to-be-recalled items.

The present studies show that representations of recently recalled memories can be inhibited. But they do not necessarily demonstrate the inhibition of the representations of those memories in long-term memory, i.e., representations from which the memories were constructed in the study phase. Racsmany and Conway (2006) argue these effects on recent memories are a product of what they term *episodic inhibition*. The central notion here is that the locus of the effects of directed forgetting and retrieval induced forgetting is in an episodic memory of the study phase. In the case of the present experiments, episodic memories arising from the study phases in each of the experiments would contain records of cue words and associated memories. Racsmany and Conway (2006) argue that subsequent processing of these study episode memories configures a pattern of activation/inhibition over their contents and when accessed in the later cued recall test it is this pattern of activation/inhibition that determines accessibility to knowledge contained in the memory. By this view, in the Barnier et al. (2002) retrieval induced forgetting experiments the effect of practicing recall of memories is to cause inhibition of representations of associated word-memory pairs held in a recent episodic memory of the study phase. It does not, or need not, cause inhibition of representations of the word cues or memories that preexisted in long-term memory (see Racsmany & Conway, 2006, for a series of experiments supporting the idea of episodic inhibition).

This notion that inhibitory processes triggered by the working self-act on episodic memories of recently recalled memories leads to some interesting clinical connections. For instance, in the study of recovered memories identified several patients who showed what was termed the "knew-it-all-along" effect (Joslyn & Schooler, 2006; Schooler, Bendiksen, & Ambadar, 1997). These are patients who recover, often suddenly and always unexpectedly, detailed and vivid memories of childhood abuse, usually sexual abuse. Although the patients were apparently wholly unaware of these aspects of their past it turns out that on previous occasions they had described the abuse, or some part of it, to another person but do not remember doing this. From the present perspective the "knew-it-all-along" effect is exactly what episodic inhibition predicts, namely that

memories of recalling the abuse can themselves be inhibited so that the rememberer is unaware that they have recalled these memories at points in the past. In these clinical cases however, added to the episodic inhibition there is also inhibition of the abuse memories themselves. According to episodic inhibition this would not be the case in laboratory experiments in which the to-be-forgotten memories would remain (highly) accessible in long-term memory and their representations only inhibited in the episodic memory of the study phase. Thus, when participants were reminded of the memories they had failed to recall by prompting with a cue from the memory rather than by trying to recall the study phase, the inhibition was abolished and the memories recalled (Barnier et al., 2006). It is not predicted that this would occur for patients' memories of abuse. These types of episodic inhibitory phenomena are not confined to patients with sexual abuse histories and PTSD. Patients suffering from a range of traumas often show similar types of forgetting. Consider, for example, the following case from our ongoing research:

A RTA patient remembered every single thing except what she said to her new husband (of 3 weeks) when she phoned him to say she had been in an accident. After some weeks of CBT, during which amnesia for the telephone call persisted, prompted by her therapist she asked him. He described how she had said "I have had an accident but I am OK. Meet me at the hospital" He then asked "Why the hospital if you are OK?". Her husband recalled that she replied, "I have hurt my legs, but its not too bad." For a while this became part of the focus of the therapy and she eventually recalled how terrified she had been that her legs were so badly hurt that she might have to have them amputated. This idea was linked to a vivid memory she had at the time, of once having to tell a female friend that the friend's father had been involved in an RTA, hurt his leg and it would have to be amputated. The patient said that she could not bring herself to tell her husband any of these thoughts, and so minimized it, because "That was not what he had signed up for," i.e., a disabled wife. In fact, she had broken one leg, and torn ligaments in the other. She made a full recovery from these injuries and her PTSD began to resolve once she recalled the telephone conversation with her husband and, importantly, the memory that had come to mind at the time of that conversation. She expressed considerable amazement that she had 'forgotten' these details of her experience. (Hackman, 2005, personal communication).[3]

[3] I am especially grateful to Professor Ann Hackmann, Consultant Clinical Psychologist at the University Department of Psychiatry, Warneford Hospital, Oxford, for drawing this case to my attention and generously allowing me to report it here.

From the present perspective this is a striking example of episodic inhibition. Clearly the patient's memory of the telephone call was inhibited but more importantly so was the troubling memory she recalled and implications of this for her self. What is inhibited here are mental representations, memories and thoughts, that foreshadow the emergence of an especially negative self-image of an amputated and disabled self. The working self can then impair access to memories and other knowledge in order to maintain goal coherence. This might occur as part of everyday memory 'housekeeping' routines in which recently acquired information of low-goal relevance has attenuated accessibility (or is inhibited) and so is unlikely to be rehearsed and, as a consequence, more likely to be forgotten. Presumably if this type of memory were accessed then its accessibility would increase. But if it is not accessed then it enters a state of more permanent inaccessibility, (cf. Tulving & Pearlstone, 1966, for further discussion of accessibility versus availability). Patterns of activation/inhibition in memories can be established by subsequent selective access of memory details. In more extreme circumstances such as those involving the experience of trauma, inhibitory processes may be more powerfully present.

Summary: The working self and the effort after coherence

In the SMS model it is hypothesized that goal coherence and self-images (derived from goals) are supported by patterns of accessibility and inaccessibility (to memories and other long-term knowledge) that have been generated by working self-control processes. These act to make highly accessible sets of memories and autobiographical knowledge that confirm and support important goals and self-images. Highly accessible memories and knowledge across the lifespan form a more or less coherent story of the individual and their achievements. Some knowledge about goals that were abandoned or which the individual failed to achieve may also have high accessibility, perhaps because these are highly instructive or directive (Bluck, 2003; Pillemer, 1998) or because they provide a confirmatory context for the achievement of other goals, e.g., 'I wasn't a success at college and left to earn money' (see Csikszentmihalkyi & Beattie, 1979). Memories and knowledge of experiences that contradict or undermine central components of the working self may, however, be assigned low levels of accessibility and in some cases may be actively inhibited. The working self's main function is to keep the goal system connected to reality by being based in comparatively accurate memories of episodes of goal processing (correspondence) while simultaneously making available memories and knowledge that support the continued pursuance of current goals and evidence of at least some positive progress (coherence).

The autobiographical memory knowledge base

According to the SMS model the autobiographical memory knowledge base in long-term memory contains two distinct types of representation: autobiographical knowledge and episodic memories. Autobiographical knowledge is organized in partonomic hierarchical knowledge structures (Barsalou, 1988; Burt, Kemp, & Conway, 2003; Conway, 1996; Conway & Bekerian, 1987a; Lancaster & Barsalou, 1997) which range from highly abstract and conceptual knowledge to conceptual knowledge that is event specific and experience-near. Autobiographical memory knowledge structures terminate in episodic memories. It is these representations and their various forms of organization that are considered in this section.

Autobiographical knowledge

Fig. 5 shows one type of knowledge structure and some broad distinctions between different types of conceptual autobiographical knowledge. At the most abstract level is a structure termed the 'life story' (Bluck, 2003; Bluck & Habermas, 2001; Pillemer, 1998). In Fig. 5 this is conceived of as being part of the conceptual self (Conway, Singer et al., 2004). The life story contains general factual and evaluative knowledge about the individual. It may also contain self-images that divide and separate the self into several different selves. These divisions may be supported by the way in which different self-images contain cues that differentially access other knowledge in the autobiographical knowledge base. For example, a self that accesses a particular lifetime period (see Fig. 5) will have cues that are channeled by knowledge represented as part of the lifetime period which in turn can be used to access particular sets of general events which contain cues to specific episodic memories.

To illustrate this, consider an individual whose profession is that of an academic. In Fig. 5, this knowledge would be part of the life story and would access schema and lifetime periods that represent personal conceptual knowledge about work. Perhaps an autobiographical fact that might be highly accessible would be where this person took their undergraduate degree, at University X. This is depicted in Fig. 5 as a lifetime period representation that contains knowledge about goals, others, locations, activities, evaluations, that were common to that period. It is this lifetime period knowledge that can be used to access more specific autobiographical knowledge at the level of 'general events' which include repeated or categoric events (Barsalou, 1988; Williams, 1996), extended events (Burt et al., 2003; Conway, 1996; Haque & Conway, 2001), and mini-histories, such as learning to drive a car (Robinson, 1992). General events as conceptual (gist) representations of events are closer in the hierarchy to representation of experience than are lifetime periods but like lifetime periods they contain knowledge about goals, others, locations, activities, evaluations, etc., but of a more event-specific nature. Thus, the lifetime period "At University X" might access the general event "Taking first year laboratory classes." This general event will contain knowledge that can access episodic memories of, for example "taking part in some card sorting experiments," "handling a Hooded Lister rat," all of which bring to mind images (sensory-perceptual episodic memories—see ahead) relating to those specific experiences. In the SMS model the conjunction of autobiographical knowledge with episodic memories constitute what is meant by the term "specific autobiographical memory."

Relatively recent experiences, particularly those occurring during the current lifetime period, that give rise to sets of multiply related general events and associated episodic memories must be represented in terms of the currently active goals of the working self that dominate at the time. Burt et al. (2003) investigated this for several extended events, e.g., Christmas shopping. In these studies events were sorted into groups created by participants and from these groupings currently active themes were identified. Fig. 6 shows the organization of a series of episodic memories associated with the general event of buying a house. Note that, Fig. 6 is constructed from the data reported in Burt et al. (2003).[4] The themes shown in Fig. 6 are all associated with other memories too and with lifetime periods in which the themes were present. The findings of Burt et al. (2003) demonstrate that general events typically access groups of episodic memories that connect the general event to unique and specific moments in time. One important property of this organization is that when goals change and new themes and lifetime periods become central to the working self, a record of the past concerns of an older version of the working self-exists in the form of general events and the colonies of episodic memories they access. Even if no goal-information is explicitly encoded it can, to at least some extent, be inferred from the groupings of general events and the associated episodic memories.

Conway and Pleydell-Pearce (2000) review the extensive experimental evidence supporting this account of the organization of autobiographical knowledge and in a later section I consider some recent neuroimaging findings that also lend another line of converging support. Here it might be briefly noted that in retrograde amnesia following brain injury the autobiographical memory knowledge base often fractionates in terms of knowledge types (this literature is

[4] I thank Professor Chris Burt for making this data available.

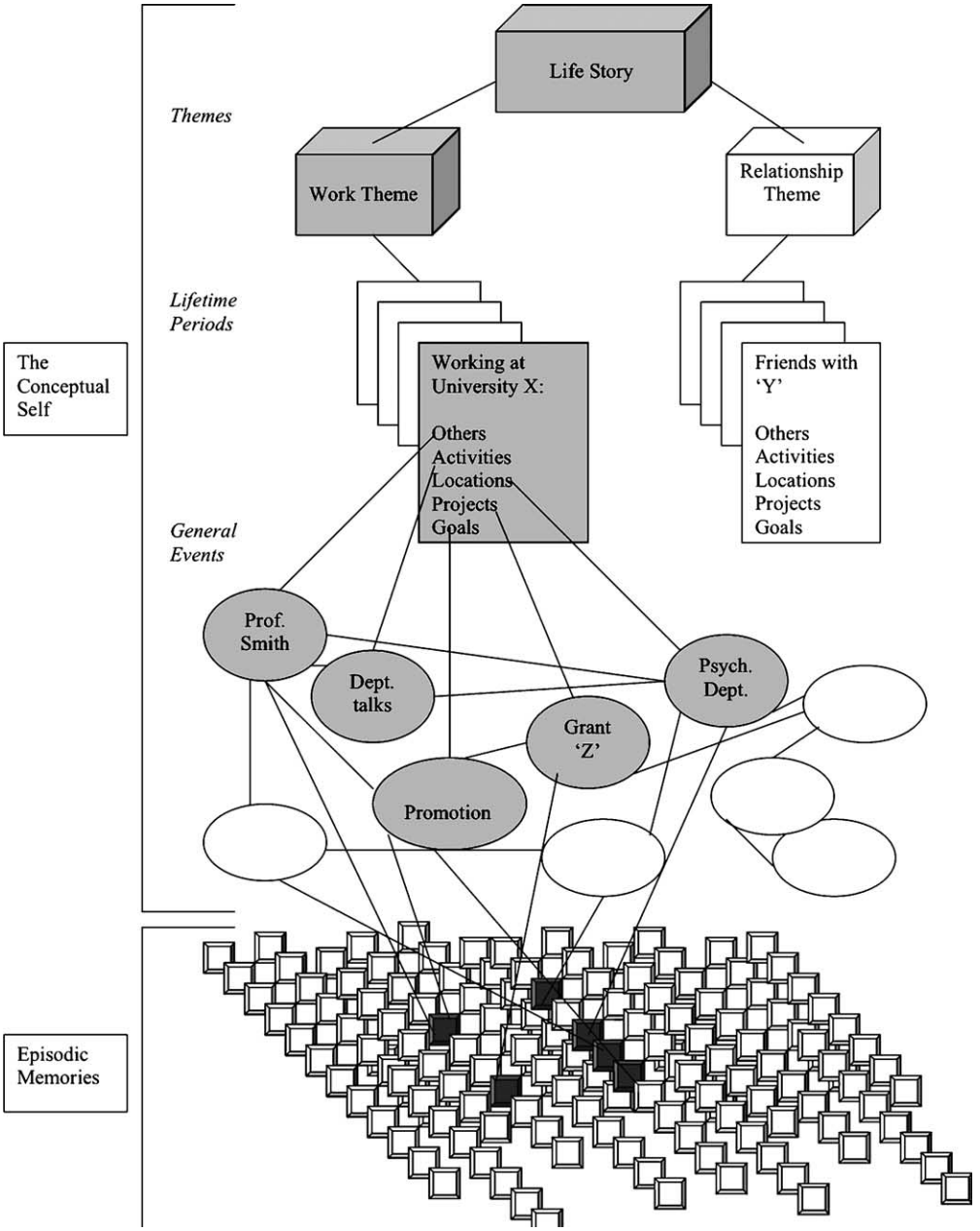

Fig. 5. Knowledge structures in autobiographical memory.

reviewed in Conway & Fthenaki, 2000). For example, most retrograde amnesics retain some conceptual knowledge of their lives and often this can be quite extensive. Even the most extreme patients, with no episodic memories, such as K.C. (Tulving, Schacter, McLachlan, & Moscovitch, 1988) and Clive Wearing (Wilson et al., 1995) retained some general autobiographical factual information. Other patients, such as SS (Cermak & O'Connor, 1983), although apparently having no episodic memories at all nevertheless had good knowledge of his past and a set of 'stories' about various events which he retained in detail. Yet, other retrograde amnesic patients have temporally graded amnesia which often extends back to roughly the period of the reminiscence bump (when the patients were young adults, see Fig. 2) and may appear relatively normal for memories in this and earlier periods. (But note that temporal gradients do not take this form in

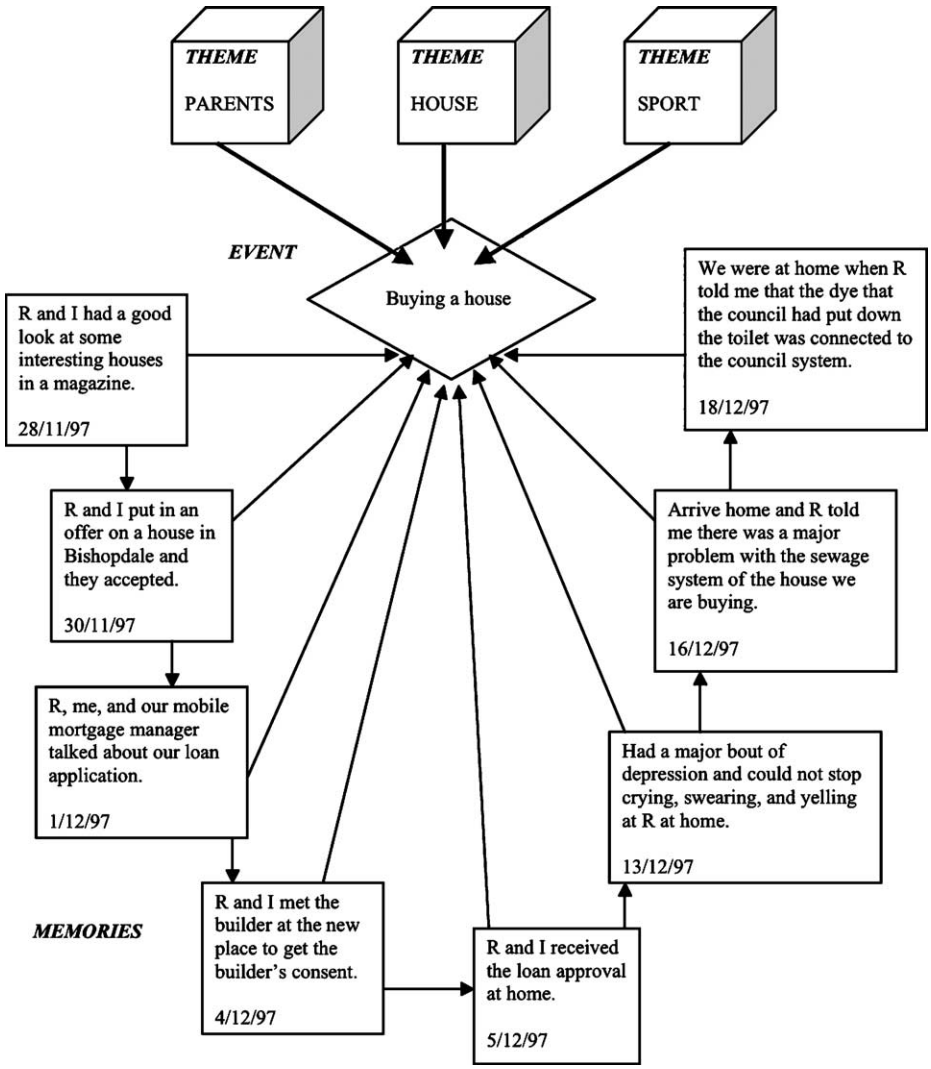

Fig. 6. Episodic memories and a general event.

all cases and temporally graded amnesics are highly variable, Conway & Fthenaki, 2000.) Indeed, one notable patient whose retrograde amnesia extended back to when he had been 19-year-old, subsequently believed himself to be a 19-year-old naval rating on shore leave during World War II (Hodges & McCarthy, 1993). In the absence of all other autobiographical knowledge in what other way can the self-define itself except in terms of knowledge currently available? Finally, it might be noted that in psychological illnesses too, access to the most specific types of knowledge, especially episodic memories, is attenuated. This is especially marked in clinical depression (Williams, 1996) but occurs in other illnesses too, e.g., schizophrenia, obsessional-compulsive disorder, etc. (see Williams et al., 2006, for a review).

Evidence from the laboratory and the study of memory disorders converges then on the view of the organization of autobiographical knowledge depicted in Fig. 5. One aspect of this organization which has been emphasized in the foregoing discussion is that subsets of knowledge and memories can be used to support and psychologically define particular self-images. Recently, we have been studying current self-images and how these are related to selective sets of memories (Moulin, Rathbone, & Conway, 2006). In these experiments participants ($n = 40$, all middle-aged) complete a short questionnaire in which they list six 'I ams...' (Kuhn & McPartland, 1954). They are instructed that an 'I am...' can be anything and that they should respond with the first six 'I ams...' to come to mind and try not to edit or select. They then provide various sorts

of information about their 'I ams' including the approximate age they were when each 'I am' first emerged. In a second phase participants recall three specific autobiographical memories to each of their previously listed 'I ams...' They recall specific memories of experiences that lasted for periods of minutes, hours, and no longer than one day and are, again, instructed to respond with the first memories to come to mind and not select or edit. For each memory they provide a short title, rate various qualities of the memories, and the date when the remembered experience occurred. Fig. 7 shows the distribution of age at encoding of the memories relative to age of emergence of the 'I ams...' Fig. 7 strikingly shows that age at encoding clusters around the date of emergence of the 'I ams...' Strongly suggesting that 'I ams...' are grounded in sets of memories of formative experiences.

The 'I ams...' collected in this study were, as might be expected, highly variable but nevertheless could to be categorized into two broad classes: roles and traits. All participants used both these categories and a typical set of 'I ams...' was: I am a father, I am a 'occupation,' I am a gardener, I am honest, I am happy, I am a hard worker (the actual mix of roles and traits in any set of 'I ams...' was variable). Fig. 7 is replotted for roles and traits separately and Fig. 8 shows the two distributions for the two sets of 'I ams...' It can be

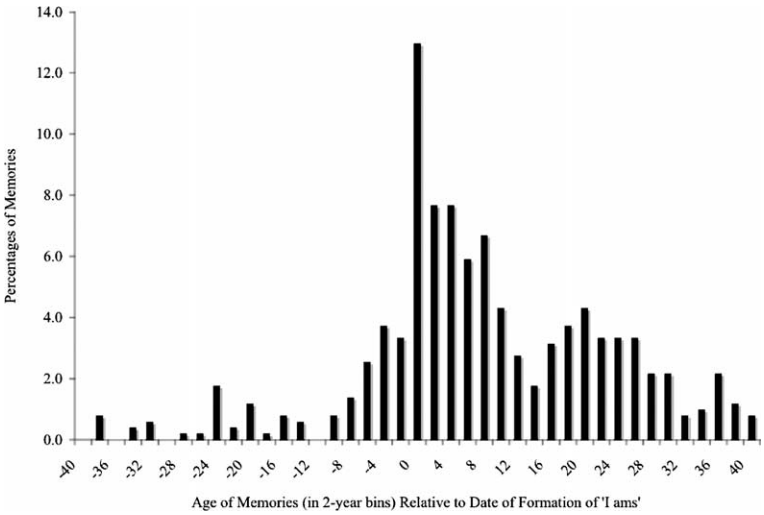

Fig. 7. Distribution of memories recalled to 'I ams...'

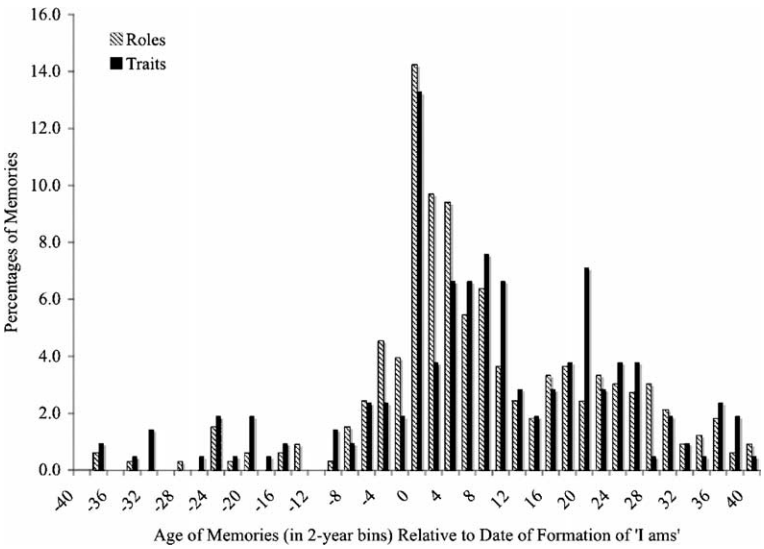

Fig. 8. Distribution of memories recalled role and trait 'I ams...'

seen from Fig. 8 that the distributions are highly similar and they did not differ statistically. Both role and trait 'I ams...' seem then to be marked in memory by highly accessible specific memories that come first to mind when the 'I am...' is processed. In our view this reflects the grounding of aspects of the conceptual self (self-images) in subsets of memories and knowledge that define and provided the content, for the individual, of that part of the self. This differentiation of the self, supported by the organization of autobiographical memory, might be particularly important in the development of the self. For example, the period of the reminiscence bump may be a period in which a sole 'I am...,' or single self-image, develops into multiple 'I ams...,' e.g., I am a son, I am a student, etc. Also at this point multiple 'I will become...' may be formed, supported by the differentiation of 'I ams...' and the final the emergence of a complete working self-goal hierarchy and conceptual self-grounded in autobiographical knowledge and memories (the SMS). Finally it might be noted that older patients with schizophrenia have been found to show an early and disorganized reminiscence bump, with an impairment of conscious recollection associated with memories highly relevant to personal identity (Cuevo-Lombard, Jovenin, Hedelin, Rizzo-Peter, & Danion, 2006). This suggests that a developmental failure present in schizophrenia is the consolidation of personal identity in late adolescence/early adulthood. Possibly, one of the features of the abnormal SMS associated with this is a failure or weakening of the grounding of conceptual autobiographical knowledge in episodic memories of formative experiences, further demonstrating the importance of coherence to an integrated self.

Episodic memory

In the SMS approach to understanding autobiographical memory the view of the nature of 'episodic' memory is an evolving one. In earlier versions of the SMS the term 'episodic memory' was not used and instead specific aspects of memory were referred to in a theoretically neutral way as 'event specific knowledge,' ESK (Conway, 1993, 1996; Conway and Pleydell-Pearce, 2000). However, it became apparent that ESK was simply the content of episodic memories and the conception of this very specific experience-near knowledge was very similar in many respects to Tulving's original conception of episodic memory (1972 and 1983) and also to the revision of the concept in Wheeler, Stuss, and Tulving (1997). Conway (2001) in reviewing the evidence arrived at the view that episodic memories are summary records of sensory-perceptual–conceptual-affective processing derived from working memory (see Baddeley, 2000) and that they form a separate memory system from the conceptual autobiographical knowledge base. It is for this reason that episodic memories can be lost, sometimes completely, in organic amnesia and psychological illness while some, or extensive, access to conceptual autobiographical memory is retained. Note too that the converse can also occur, that is preserved episodic memory with degraded, or loss of, conceptual knowledge (see Hodges & Graham, 2001, for a review). The separation of conceptual autobiographical knowledge from episodic memory also explains why when accessing autobiographical memory under normal circumstances specific autobiographical memories are not always formed. Conway (1996) proposed that the level of general events is the preferred level of access to autobiographical memory, it is in Rosch's (1978) terms a basic level in this class of knowledge. That is to say that the level of general events is the level at which knowledge is optimized in terms of its informativeness and ease of access. In the current version of the SMS the episodic memory system is conceived of as a separate system in which representations have the characteristics listed in Table 3, (note, this is not an exhaustive list and it is anticipated that new characteristics will be added). Much of the evidence in support of the characteristics listed in Table 3 is reviewed in several recent papers, e.g., Wheeler et al. (1997); Conway and Pleydell-Pearce (2000), Conway (2001), Conway, Singer et al. (2004)—see also Tulving's (1983) important extended account—and it is not intended to repeat those reviews here. Instead the focus is on the content and form of individual episodic memories and the nature of recollective experience.

The content of episodic memories

In Table 3, following Tulving (1983), episodic memories are viewed as containing summary records of sensory-perceptual–conceptual-affective processing that characterized or predominated in a particular experience. Some of this knowledge will be copies of specific patterns of activation/inhibition that existed over networks in affective and motor systems during the experience. For instance, the fear and anxiety associated with looking at oncoming car headlights prior to a major RTA may be literally represented in an episodic memory of the experience (see Ehlers et al., 2004, for a series of related PTSD cases). More prosaically the pattern of activation/inhibition of a fragment of a semantic category might be contained in an episodic memory of learning a study list (Racsmany & Conway, 2006). There may even be very specific representations of motor movements. For example, a PTSD patient who was involved in an RTA had the experience of intense anxiety every time he leaned his upper torso forward while sitting down. During reliving in CBT he recalled that as his vehicle was struck at speed from behind he was thrown forward and as this

Table 3
Ten characteristics of episodic memory

I.	Retain summary records of sensory-perceptual–conceptual-affective processing derived from working memory.
II.	Retain patterns of activation/inhibition over long periods.
III.	They are predominately represented in the form of (visual) images.
IV.	Represent short time slices, determined by changes in goal-processing.
V.	Represented roughly in their order of occurrence.
VI.	They are only retained in a durable form if they become linked to conceptual autobiographical knowledge. Otherwise they are rapidly forgotten.
VII.	Their main function is to provide a short-term record of progress in current goal processing.
VIII.	They are recollectively experienced when accessed.
IX.	When included as part of an autobiographical memory construction they provide specificity.
X.	Neuroanatomically they may be represented in brain regions separate from other (conceptual) autobiographical knowledge networks.

happen he had a sudden memory of someone he had known who had broken his neck and simultaneously realized that this was about to happened to him. Episodic memory for specific motor movements although not uncommon in PTSD clearly needs to be studied under more controlled conditions. At the moment the clinical evidence strongly indicates that this does occur, but as yet there are no formal studies. In addition to all this highly experience-specific content, there may be some more conceptual knowledge about the experience, rather than deriving directly from it, such as evaluative knowledge, e.g., it was a good, bad, or dull experience, one achieved or did not achieve certain goals, and so forth.

Characteristics I and II in Table 3 are about episodic memory content. Characteristic III is also but in a slightly different way as it mainly concerns the way in which episodic memories come to mind. Brewer (1986) originally pointed out that many specific memories come to mind in the form of imagery and especially visual imagery. In subsequent research he established that memories containing visual images constitute more than 80% in a set of randomly sampled memories (Brewer, 1988). Others have reported similar findings, e.g., Whitten and Leonard, 1981, Williams and Hollan (1981), and it has been known for some time in the neuropsychological literature, see for example, Conway (1996), Conway and Fthenaki (2000) for reviews, and Rubin and Greenberg (1998) for a recent treatment. Visual imagery predominates in episodic memory and the loss of the ability to generate visual images may give rise, as a secondary consequence, to retrograde amnesia, see Ogden (1993) for an especially interesting case. Note too, that when amnesia occurs as a secondary consequence of the loss of the ability to form visual images, conceptual autobiographical knowledge appears to remain intact. This view of the content of episodic memories might appear at first to constitute a fairly extreme correspondence theory. Yet this is not the case. Episodic memories are records of experience and correspond to reality only to the extent that the extended pattern of internal processing during an experience accurately represents reality. By the SMS view most episodic memories will be a mix of processing relating to both the external and internal milieu. Which dominates, external versus internal, is determined by issues relating to coherence.

The period represented by episodic memories

One important question is: what is the length of an episodic memory? What period of time does it cover? If a person studies a word list do they have a single episodic memory? Several? Is there a memory for each word? The SMS answer to the question of what period an episodic memory represents is based on a consideration of goals. Episodic memories are records of short-term goal processing and so should be formed at junctures in goal processing (Table 3, VIII). But goal junctures can occur at many different levels, from making a cup of tea, answering a telephone call, to writing a paper, etc. The SMS framework proposes that episodic memories are formed at goal junctions of action sequences when there is major change in the predominating goal. For example, in typing the fine grained goals of striking the keys, are not points at which episodic memories are formed. Ceasing to type and moving to some other activity, making a cup of tea, daydreaming, etc. should, according to the SMS, be points at which episodic memories are formed. In any given day then many memories will be formed but relatively few will remain accessible for enduring periods of time (Table 3, VII). Thus, a person can remember in great detail their trip to work this morning and other features of the day's activities. Within a short retention interval, perhaps as little as 24 h, most of these recent episodic memories are no longer accessible. Only those with an enduring association with current goals are retained and even then must become integrated with knowledge structures in the autobiographical knowledge base if they are to be retained in the long-term. In current studies in our laboratory, we have been attempting to examine some these aspects of episodic memory using a simple procedure (Conway, Williams, & Baddeley, 2005). Participants

upon arrival at the University of Leeds come to our laboratory and in a surprise free recall test, recall all they can about what happened, including thoughts and feelings, between leaving their home and arriving at the laboratory. They list this information in the order in which it comes to mind. Next they go back through their written account and divide it into discrete memories. They are given no detailed instructions for this but are simply asked to mark it as they see it (see Newtson, 1976, for a similar procedure used in determining 'event' boundaries). It is explained that there are no correct or incorrect answers and we are interested in how different people divide up this type of information into memories. Having marked their memories participants then indicate in what order the remembered experiences occurred from first to last. Two judges independently read the memory descriptions and developed a coding scheme used to classify each of the statements in a memory description. The coding scheme contained the following categories: action, thought, feeling, location, and fact.

A number of findings emerged from these data. Relating to characteristic V in Table 3 comparatively few participants listed their memories out of temporal order. All started with their departure from home, some then had one or two memories subsequently listed as occurring, one memory back. This is at least some preliminary evidence that recent episodic memories are not yet order by themes, self-images, and the knowledge structures of autobiographical memory (see Figs. 5 and 6). Instead temporal information appears to play a prominent role, at least in the output of these memories. Another finding relates to the beginnings and endings of the episodes. Table 4 shows the distribution of first (start) and last (end) memory details in percentages judged to be in the content categories. It is clear from Table 4 that the start of memories is predominantly marked by actions whereas the last details in these recent episodic memories take a wide variety of forms. Other research has also found that changes in activities mark event boundaries (Newtson, 1976; Zacks, Tversky, & Iyer, 2001) and in our terms these reflect changes in goal processing. It seems from our preliminary data that recent episodic memories start with actions that indicate goal change, i.e., meeting people on the way into University, conversations, catching buses, walking particular routes, and so forth. In contrast to start details, end details are more varied and do not predominantly take the form of actions. If, as the SMS framework proposes, goal-processing mediates the formation of episodic memories it seems from the present findings that commencing new actions may trigger encoding processes. Possibly, encoding processes are terminated not by the end details collected here but rather by the implementation of new actions, marking the start of a new episodic memory. Finally, when retested one week later very little was recalled and no temporal order was present. Interestingly what little was recalled was mainly what had been written by the participants a week earlier and they were able to distinguished between actually remembering an event from their trip to work the week previously and their memory for writing about it.

Table 4
Classification of first and last details in episodic memories for very recent events

Type of detail[a]	Position of detail	
	First	Last
Action	67.00	16.28
Fact	21.58	40.07
Thought	3.46	9.02
Feeling	1.29	2.97
Visual perception	4.78	4.21
Auditory perception	1.52	0.30
Evaluation	0.38	7.90

[a] Note that 24 memories had only one detail and these were not classified.

Memory awareness and episodic memory

The experience of remembering or autonoetic consciousness has become an important area of research arising from Tulving's (1985) classic paper, (see Gardiner & Richardson-Klavehn, 1999, for review). In autobiographical remembering autonoetic consciousness occurs when episodic memories enter consciousness (see Table 3). Within the SMS framework autonoetic consciousness is considered to be a defining feature of the experience of remembering (Wheeler et al., 1997). In Tulving's (1985, 2002) memorable phrase recollective experience is a type of 'mental time travel' in which the past is experienced. Note that, this does not necessarily entail re-experience (cf. Roediger & McDermott, 1995), and instead what is important is the feeling of remembering. Possibly one of the functions of recollective experience, is to signal to the rememberer that they are in fact remembering (Conway, 2001). That is to say that the feeling signals the state in a experiential way. Recollective experience, the sense of the self in the past and the episodic imagery that accompanies that sense, indicate to the rememberer that they are in fact remembering and not daydreaming, fantasying, or in some other non-memory state.

Related to this possible signaling function of recollective experience we have recently had the opportunity to study some neuropsychological patients who suffer from a striking malfunction of autonoetic consciousness (Moulin et al., 2006). All these patients suffer from chronic and intense experiences of déjà vecu: the feeling of having lived the present moment before. This can be

Table 5
Over-extended recollective experience in patient AKP's recognition memory performance

	Hits			False positives		
	R[a]	F	G	R	F	G
AKP	0.75	0.15	0.10	0.57	0.21	0.21
Controls	0.88	0.09	0.03	0.17	0.50	0.33

[a] R, recollective experience; F, a feeling of familiarity, and G, a guess.

distinguished from the experience of déjà vu which is the feeling of having seen something before, which we believe is more properly associated with the feeling of familiarity or noetic consciousness (Moulin et al., 2006). In formal testing these patients overextend recollective experience to the large number of false positive errors that they make in standard recognition memory tests. Table 5 shows data from one of these patients (patient AKP) and it can be seen that compared to controls AKP has a vastly increased false positive rate and that most of these are judged by AKP to be items for which he has the experience of remembering.

AKP and other patients we are currently studying are asked to justify their recognition memory responses and describe what in their memory experience has led them to a particular response. Table 6 lists a representative set of the protocols from patient AKP. It can be seen from these that AKP makes an entirely appropriate use of the response categories (remember, familiar, and guess) and one which is indistinguishable from that of age matched healthy controls. It seems from this that AKP actually experiences false positives as old items. For AKP, and the other patients we have studied, this powerful and pervasive experience of recollection gives rise in their everyday lives to what we have termed recollective confabulation (Moulin et al., 2006). AKP constantly confabulates 'explanations,' based on his déjà vecu, of how it is that he remembers something he cannot possibly remember. For instance, he rejected reading the newspaper because he had read it before, claiming that he had done so while out for an early morning walk (which was untrue). He no longer watched television because it was all repeats, no longer read his journals (he was a former engineer), books or letters, because he had read them before. While walking with his wife who found a coin on the path, he remarked that he was pleased that she had found the coin he had put there for her to find. These and many other examples, from the other patients too, were frequent and highly disruptive.

AKP's most revealing recollective confabulation occurred while he was being interviewed during a radio program. The interviewer challenged AKP to justify his claim that he had been to the studio before and undertaken exactly the same interview with the same interviewer. To

Table 6
Justifications for memory awareness responses in a recognition memory study

Stimuli	Status	R/F	Justification
AKP			
Science	FP	F	Just rings a bell, familiar word
Bargain	FP	F	I just feel I saw it, what else can one say?
Plaza	FP	R	Polish is the same, it means 'beach'
Enigma	FP	R	Enigma Variations, it sticks in the mind
Abode	FP	R	It just seems like I remember it. I can't explain, except the symmetry at presentation
Edict	Hit	F	Just a feeling
Modernist	Hit	F	Its vague, I think I saw it before
Handkerchief	Hit	R	Because I haven't got one, I always forget it
Gondola	Hit	R	I remember seeing this at the beginning
Polka	Hit	R	Polka is Polish for female
Control			
Preference	FP	F	I think I saw it, not remember
Employment	Hit	F	I think I heard it
Arrival	Hit	F	I'm not sure, it just seem (to be old) to me
Fissure	Hit	R	I saw rocks opening
Handkerchief	Hit	R	I thought the word is so out of the group, the others are posh
Gondola	Hit	R	Almost certainly, it is a romantic thing.
Polka	Hit	R	I made an association with a polka dot. It's a Polish word, it means woman

FP, false positive; F, a feeling of familiarity; R, recollective experience.

the interviewer's incomprehension AKP then proceeded to describe the studio, the clothes worn by the interviewer, and the questions asked, as though they were in the past. AKP experienced the present as the past. This over-extension of autonoetic consciousness was most evident when he was in novel situations but also was present to some degree virtually all the time. In the recognition memory tests it became apparent that what triggered recollective confabulations was not the presentation of the (new) word but instead the association that AKP made to that word. For example, in Table 6 it can be seen that in response to the word 'handkerchief' AKP claimed that when he saw this word during the study phase he thought 'I usually forget mine' and that he now recollectively experienced this thought. But he was incorrect in that he must have made this association at test (the word had not previously been presented) and only at that point did he recollectively experience it and on that basis incorrectly infer that

'handkerchief' must have been a studied word (a striking instance of recollective confabulation). We believe that this process of recollectively experiencing one's current thoughts and perceptions was what underlay AKP's frequent experience of déjà vecu and pervasive recollective confabulations, (see Moulin et al., 2006, for a review of related patient work and Brown, 2003, for a general review of déjà vu states).

The patients reported in Moulin, Conway, Thompson, James, and Jones (2004) had marked atrophy in the temporal lobes. However, another patient with overextended autonoetic consciousness on formal memory tests was known to have frontal rather than temporal lobe lesions (Schacter, Curran, Galluccio, Milberg, & Bates, 1996). On the basis of this and other findings Moulin et al. (2006) suggested that circuits in the medial temporal lobes might generate recollective experience but that conscious experience of recollection could only enter awareness through a route modulated by frontal (working self) control processes. In our déjà vecu patients, we argued that the connection between control processes and a hypothesized medial temporal lobe recollective experience circuit had become attenuated or disrupted altogether. According to the SMS account cues constantly activate autobiographical knowledge and episodic memories but the effects of these activations are prevented from entering consciousness by the working self as this usually would disrupt processing and the effective pursuit of current goals. For AKP this system of interlocked distributed networks was attenuated such that activated episodic memories were still prevented from entering conscious awareness but their effect in triggering the recollective experience circuit occurred unchecked and hence the pervasive state of autonoetic consciousness and persistent experience of déjà vecu. More generally this account of a malfunction of autonoetic consciousness is consistent with current thinking about one possible the function of consciousness, namely Baars's (2002) conscious access hypothesis. The suggestion is that consciousness serves an integrative function and acts to temporally bind together networks that operate nonconsciously, separately, and independently. This fits well with the idea that when a stable pattern of activation in long-term memory becomes linked to the working self then consciousness of what has become available can, potentially, occur. When the pattern of activation encompasses episodic memories then autonoetic conscious may result with all that entails i.e., the turning inwards of attention, the emergence of imagery, feelings, and the coming to mind of associated knowledge and memories. Autonoetic consciousness in the SMS may then reflect the integration of parts of the knowledge base and the working self in a dynamic act of remembering as well as signaling to the individual what state they are in, i.e., remembering and not some other state. The role of episodic memories in autobiographical remembering is key and these memories support, in the healthy brain, a link to a detailed past that can be experienced as past.

Constructing autobiographical memories

When a cue activates part of the autobiographical knowledge base then knowledge becomes available to evaluative control processes. These processes can either terminate the search or initiate a new search cycle with a cue elaborated on the basis of the preceding search. This iterative model of memory construction, search–evaluate–elaborate, was originally proposed by Norman and Bobrow (1979). Subsequently it was developed further by Williams and Santos-Williams (1980), adopted for the SMS model (Conway, 1990, 1992, 1996; Conway & Pleydell-Pearce, 2000), and recently extensively expanded by Burgess and Shallice (1996). We refer to this process as generative retrieval and contrast it with direct retrieval (see Moscovitch, 1995, for a similar distinction). The two types of retrieval are, however, closely related and all generative retrieval cycles end in direct retrieval, i.e., when the cue accesses the sought-for-knowledge. The only major difference between the two is that direct retrieval does not entail iterative searches of knowledge base as depicted in Fig. 9. In this section, both types of retrieval are briefly considered as well as the evaluation process or use of retrieval models.

Generative retrieval

Table 7 shows two protocols collected from participants reporting the contents of consciousness while recalling specific autobiographical memories to the cue words shown at the top of Table 7. These data are taken from several unpublished protocol studies and are organized in terms of pauses in the protocols in which, typically, some information is initially reported, followed by a pause, followed by new information, and so on until a specific memory is formed. They provide a good example of what is meant by the term 'generative retrieval' and that is why they are included here. They also draw attention to several interesting points. We have found in these studies of generative retrieval that participants frequently (over 60% of trials) commenced retrieval by elaborating the cue so that it corresponded to some aspect of their current life. In the case of cues that name objects this often takes the form of recalling the named object from their home or office. It is as though the current physical environment maps onto autobiographical knowledge in a particularly direct way. The objects in our current physical environments may have highly specific associations to particular current goals and so to the working self. Alternatively, it was found that the initial processing of a cue in a cycle of generative retrieval might

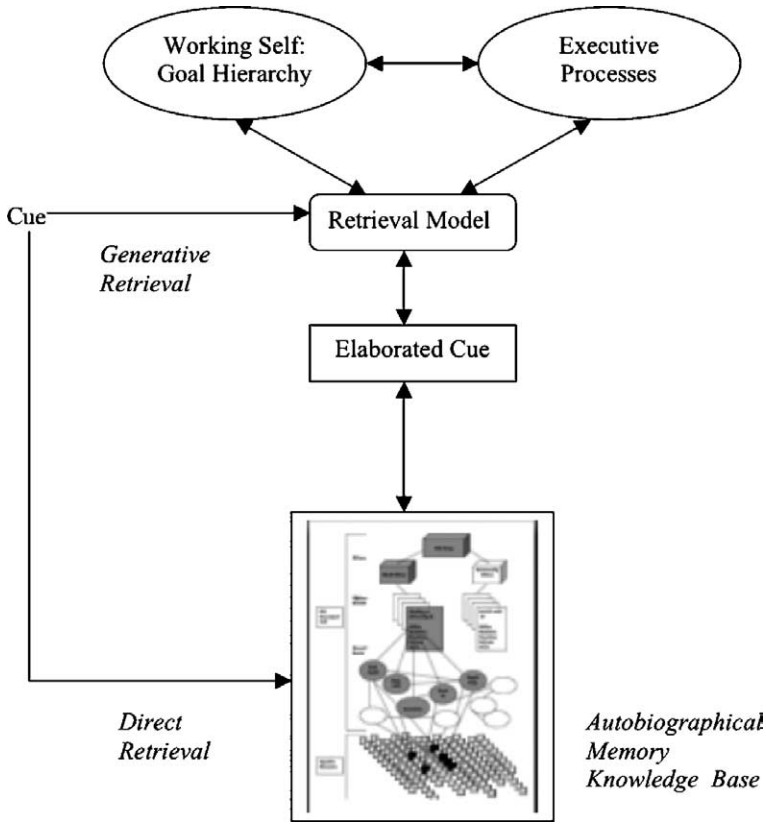

Fig. 9. Direct and generative retrieval.

Table 7
Schematized memory protocols

Cue word
Bicycle
I can see my own bicycle at home in the garage
I rode it a lot when I was home last year in the summer but not at Christmas because of the weather
There is a pub on the canal near us and 'X' and I cycled there and it was completely packed out with people sitting outside on the walls, everywhere—(followed by series of detailed descriptions of buying drinks, seating arrangements, etc.)
Seaside
When did I last go to the seaside?
I just had an image of a beach in Cornwall
I'm trying to remember going there on a holiday just after I left school, before college
I remember we bought some nets, just like kids
And now I remember a rock pool and we had out nets in the water, and our trousers rolled up, and we had a bucket too, I don't know where that came from—(followed highly specific mainly visual descriptions of trying to catch small fish with her friends)

commence with an elaboration of the cue in terms of the organization of autobiographical knowledge, e.g., selection of a lifetime period or general event to search. Table 7 shows protocols for both these types of elaboration. Note that, on some trials there was no generative retrieval and a memory came rapidly and directly to mind. When generative retrieval was present the initial elaboration of the cue was followed by further elaborations and in most cases retrieval was terminated when a set of vivid images (episodic memories) enter awareness. The number of elaborations in iterative searches that were undertaken was highly variable but over 80% terminated within five elaborations (or at least as we measured these). There are some

searches that persist for the full 30s of the maximum trial length never accessing specific memories and some others that terminate in conceptual knowledge rather than episodic memories. Finally, there were a few trials which showed signs of 'blocking.' That is some, often conceptual, knowledge would come to mind and remain in mind with the participant claiming to be unable to progress further.

To investigate the process of generative retrieval further Haque and Conway (2001) conducted a series of probed retrieval experiments. In this procedure participants recall specific autobiographical memories to cue words but are presented with a probe signal at 2s, 5s, or are allowed as long as they need to recall a memory (30s). In response to the probe, or if they recall a memory, whichever occurs first, they report the contents of consciousness. Haque and Conway (2001) developed a coding scheme to classify the content of the resulting protocols. The classes were: specific memory, autobiographical knowledge (general events and lifetime periods), or nothing in mind (NiM), see Conway and Haque (1999), for a full account of this classificatory scheme. Fig. 10 shows the number of responses classified at each probe deadline, 2s, 5s, and 30s. For specific memories over 44% were found to occur at the 2s deadline. For responses featuring autobiographical knowledge, but not specific memories, approximately 38% were present at the 2s deadline. At the 5s probe specific memories increased and autobiographical knowledge decreased until at the 30s probe deadline virtually all responses were specific memories or retrieval failures (of which there were very few). Thus, instances of direct retrieval are present very rapidly and these are trials which either did not feature generative retrieval at all or which had very few cycles of elaboration and search. One connection that can be made here is to the clouded or categorical autobiographical memories seen in frontal (Baddeley & Wilson, 1986) and depressed Williams (1996) patients, respectively. In these patients it seems likely that there has been some impairment or attenuation of generative retrieval such that the whole process terminates too early in the generative cycle. This might be due to a failure to elaborate a cue appropriately or to some failure of the evaluation processes. From the examples in the literature it seems that in these disorders the former may be more frequent then the latter (see Williams et al., 2006, for review).

Direct retrieval

Undoubtedly the most well-known account of an experience of direct retrieval comes from Proust (but see Salaman, 1970, for many other examples from literature and Berntsen, 1996, for some recent survey evidence). In Remembrance of Times Past, Proust (1925/1981) recounts how the tastes of a madeline cake dipped in warm tea suddenly brought to mind a whole section of his life he had previously thought lost to recollective experience (see Chu & Downes, 2002, for experimental evidence). Assuming this to be true it is unusual because the experience (or at least the way in which Proust describes it) was an opening up of a known period of his life in a way that allowed it to change from a noetic to an autonoetic experience of remembering. The power of a cue to bring about this type of change from an experience of knowing to one of recollection has also been observed in two cases of organic amnesia (Lucchelli, Muggia, & Spinnler, 1995). In one of these, the act of having a pacemaker fitted suddenly lead to the recovery

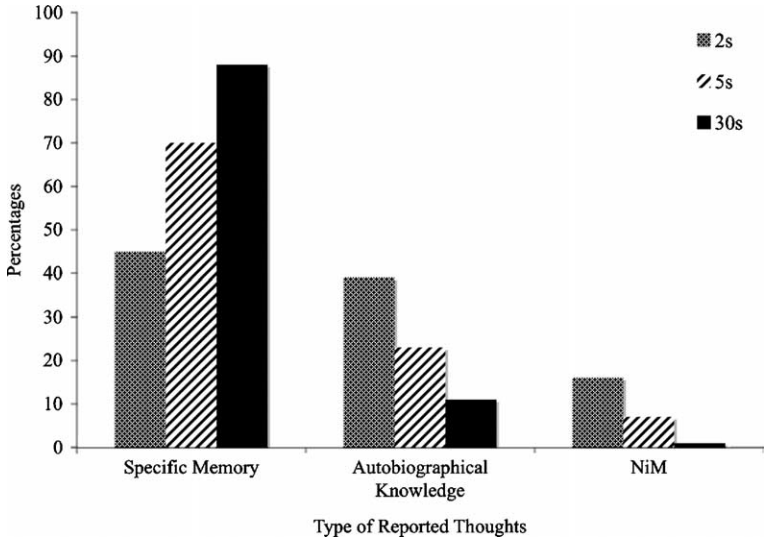

Fig. 10. Distributions of memory types present at different probe delays.

of many memories from an almost total retrograde amnesia with the memories returning to mind in groupings, e.g., all medical memories, school memories, etc., over a period of days following the initial access to a memory of having a pacemaker fitted previously. In the second, a young man following an RTA presented with an extremely dense retrograde amnesia, he could not for example recognize his girlfriend, modern telephones, or any family members. Some months later when playing tennis—he was a highly skilled amateur—he made an error with a particular stroke and immediately recalled making the same error in a match months previously. At that point his 'tennis' memories began to return followed by other groups of memories.

Impressive though these cases are the main two areas in which direct retrieval is most evident are in PTSD and for very recent experiences. Memory in PTSD has already been touched upon and it might simply be noted here that intrusive highly detailed episodic memories often triggered by very specific cues are a major symptom of the disorder. Ehlers et al. (2002) provide a wide range of case studies many featuring vivid flashback recall occurring rapidly in response to highly specific cues. For instance, in one case a woman in a restaurant started to feel intensely anxious and have flashbacks to a traumatic episode in which she had been assaulted. After some time she suddenly became aware that a man on an adjacent table had a beard that was highly similar to the beard of her assailant. In another case a cyclist who had been run over by a truck from behind had no memory for his RTA. Subsequently, he was referred for treatment for dangerous (car) driving, of which he had no prior history. He described how when driving if he looked in his rear view mirror and saw headlights, particularly those on buses or trucks, he became anxious and felt strongly compelled to drive as quickly as he could until the headlights were no longer visible. The patient did not connect this compulsion with his accident. Nevertheless, when it was pointed out to him he began to feel that he understood his compulsive driving behavior and he began to control it: yet he never recovered his memory of the RTA. Such nonconscious effects of direct retrieval parallel nonconscious memory effects originally studied in the laboratory by Jacoby and colleagues (see Jacoby, Kelley, & Dywan, 1989, for review).

These sorts of cases illustrate a principle of memory first formulated by Tulving and Thomson (1973), namely the encoding specificity principle, i.e., the idea that at some point during retrieval some item of knowledge in the search set must correspond to an item of knowledge in the sought-for-knowledge in long term memory. The term 'direct retrieval' is simply a convenient synonym for encoding specificity (see Moscovitch, 1992, for alternative terminology). By the SMS approach instances of direct retrieval should be most frequent in recent memory because the objects, actions, feelings, and thoughts occurring in the recent past (perhaps 24 h or less) are closely associated with current highly active and accessible goals. As these working self-goals continue to be processed then it would seem inevitable that, by encoding specificity alone, knowledge would be processed that formed an effective cue to recent episodic memories and direct retrieval would then occur. Little is known about how the current environment, internal and external, drives direct retrieval in daily life. This is an area that awaits investigation (but see Schank, 1982, for some interesting examples).

Retrieval models

In the SMS view of memory construction accessed knowledge is evaluated by a retrieval model (a concept similar to Norman & Bobrow's, 1979, notion of a 'memory description'). A retrieval model is a control process of the working self and, it is hypothesized, one that develops during infancy and childhood under the influence of socialization and cultural factors as discussed earlier (see Wang & Conway, 2006 & Nelson & Fivush, 2004, 2006, for related theory). A possibility here in terms of development is that the episodic system is functional early in development, possibly even from birth but that the organizing conceptual knowledge and retrieval models that modulate the whole system only develop later. The evidence indicates that infants appear to have memories that are episodic-like (Table 3) and highly responsive to episode-specific cues (Rovee-Collier, 1997). Neurological evidence on the slow development of neural networks in the frontal lobes, especially over the first 5 years of life, also suggests that processes that might control and coordinate memory are slow to emerge (Kolb & Wishaw, 1995). This slow emergence perhaps allows socialization processes to shape the formation of organizing conceptual autobiographical knowledge (cf. Nelson, 1978) and the formation of retrieval models.

We believe that the main function of a retrieval model is to separate mental representations that are memories from those that are not. The model, thus, specifies what classes of knowledge have to be combined for a mental representation to be a memory. This requires at a minimum: recollective experience, the turning of attention inwards, and emergence of certain types of knowledge into consciousness. These are the 'constraints' of the retrieval model that have to be satisfied if a mental representation is to be experienced as a memory and not as some other type of mental phenomenon, e.g., fantasy, day dream, imagery, thought, etc. There will, however, be other constraints that also have to be satisfied, i.e., tasks demands for specific types of memories. These will be particular to specific episodes of memory construction and will act to make each retrieval model unique. Thus, recalling with a friend a recent shared

vacation will feature a retrieval model that specifies some constraints that are quite different from those present when the same memories are recalled in an autobiographical memory cue word experiment. Nevertheless, on both the occasions of recall constraints common to all retrieval models will be present, e.g., the requirement for recollective experience, etc. Retrieval models are then derived from a general control process and embody the constraints specified in that process while additionally containing constraints specific to each individual act of memory construction.

In the formation of a specific autobiographical memory one of the major general constraints is that episodic memories and autobiographical knowledge be brought together. We have suggested this occurs by a cue establishing an appropriate pattern of activation in long-term memory. A process that can occur directly with little input from the working self or which occurs generatively and features iterative cue elaboration. In either case the eventual mental representation must minimally satisfy the common or general constraints of the retrieval model. Clearly, if the control process that specifies general constraints or standards for all memories were to malfunction then other types of mental representations could be experienced, reported, and acted upon as memories. As discussed earlier something like this appears to occur in plausible confabulations that can emerge following brain injury to regions of the frontal lobes. One suggestion, based on the SMS account of memory, is that the general retrieval model control processes malfunction so that, intermittently (frontal confabulators often have correct memories too, Baddeley & Wilson, 1986; Conway & Tacchi, 1996), parts of the conceptual self, i.e., self-images, are experienced as memories. The frontal lobe patients described earlier who suffered from motivated confabulation provide some evidence of this intrusion of pleasant or paranoid goals in the form of self-images into retrieval models where they are experienced as memories. In summary, comparatively little is known about the construction of memories. What evidence there is largely comes from protocol studies and neuropsychological case studies. The investigation of memory construction processes remains a challenge. As we shall see in the next and final section there is now compelling neuroimaging evidence demonstrating that construction must indeed take place.

Neuroanatomical bases of the autobiographical remembering: Two memory systems?

One striking feature of autobiographical remembering is that memories take a considerable amount of time to form, relative that is to other types of knowledge access. Access to word meaning has been found to occur in periods a few hundred milliseconds in duration (see Neely, 1991, for review) image generation times for common items are on average around one second, even access to autobiographical factual knowledge typically averages around 1200 ms (Conway, 1987). In contrast, autobiographical memory retrieval times are highly variable and means in the range 5–7 s are not uncommon (see Conway, 1990). Even when the cues are highly specific being taken from the participants' own autobiographical knowledge, mean retrieval times are in the range 2–3 s (Conway & Bekerian, 1987a). The evidence from experiments, neuropsychology, and psychological illnesses, all point to a lengthy construction process, involving search, evaluation and the formation of a stable pattern of activation over autobiographical memory knowledge structures that includes imagery. If this view is correct then we should observe the dynamic emergence over time of widely distributed patterns of brain activation during the retrieval and formation of autobiographical memories. This is exactly the finding of a series of neuroimaging studies of autobiographical remembering. Here I will briefly summarize these findings and then consider a hypothesis they suggest about the evolution of autobiographical memory. It might be noted that very detailed reviews are also available in Conway, Pleydell-Pearce, Whitecross, and Sharpe (2002), Markowitsch (1998), and Maguire (2001).

Time course of activations during autobiographical remembering

In a series of EEG studies we have examined the time course of activations present during retrieving (constructing) a memory and then holding that memory in mind for a set period of time (Conway, Pleydell-Pearce, & Whitecross, 2001; Conway et al., 2001). EEG is especially suited to tracking the evolution of activations over what is a lengthy and variable period of retrieval for each individual memory. The cost of this fine temporal resolution is relatively weak topographical localization, nevertheless as one of our main interests has been in how the pattern of activation unfolds over time we have focussed on EEG. In these EEG experiments participants recall memories to cue words. Changes in slow cortical potentials (SCPs) are monitored during the pre-retrieval period, retrieval, and while a memory is held in mind, usually for a period of 5 s. Fig. 10 shows averaged head plots for three epochs from each of these three periods (areas colored red depict highly active regions and areas colored blue indicated regions that are dysfacilitated).

The top line of Fig. 11 shows changes in SCPs during the epochs 3, 2, and 1 s (from left to right in the Fig. 11) prior to cue word on screen, (these head plots were modeled using several different baselines, see Conway et al., 2001, for full details). In the pre-retrieval period activation builds in the left anterior temporal lobe, in the region of the temporal pole. The initially diffuse

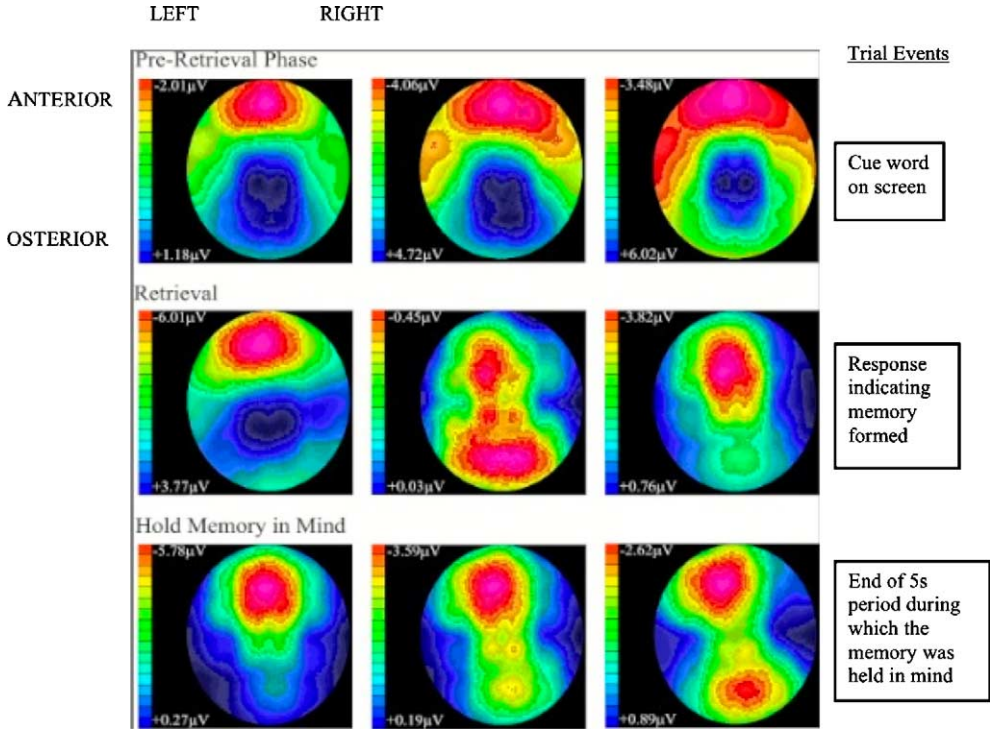

Fig. 11. Head plots showing patterns of neurophysiological activation present at different points during the retrieval of autobiographical memories (note that, areas colored red depict activated regions and area color blue indicate deactivated regions). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this paper.)

activation in the frontal lobes settles into intense foci of activation mainly in the left frontal lobe (see too Conway et al., 1999, for a similar finding using PET). In the period 1 s prior to cue word on-screen left anterior temporal and frontal networks are highly activated or primed for retrieval. Note too, that at this point posterior networks are not activated but rather are dysfacilitated or, perhaps, inhibited. According to the SMS view these patterns reflect the priming of working self-memory construction processes in the frontal networks. The left anterior temporal activation might possibly reflect the priming of conceptual autobiographical knowledge that could be used in the elaboration of cues.

The cue word appears on screen (the phasic components associated with the semantic processing of the cue word are not shown in Fig. 11) and retrieval then commences. The middle row of Fig. 11 shows head plots depicting changes in SCPs at a point 1 s into retrieval (left plot), at the midpoint of retrieval which, of course, varies with retrieval time (middle plot), and the right side plot shows the epoch 1 s prior to a response indicating that a memory had been formed. Initially the pattern of activation contracts to foci primarily in the left medial prefrontal cortex. However, by the midpoint of retrieval activation has spread to posterior networks in the posterior temporal lobes and most markedly in the occipital lobes, bilateral in both cases but stronger in right than left occipital regions. Note this pattern was present for both slow and fast retrieval times (see Conway et al., 2001). By our account this reflects working self-control processes accessing and activating episodic memories stored in posterior networks. In the last second of retrieval, (right plot of the middle row of Fig. 11), activation again contracts to frontal and motor regions. This reflects a switch in activity from forming a memory to making a manual response to indicate that a memory is now in mind.

The bottom row in Fig. 11 shows (working from left to right) the epoch 1 s post-retrieval (while a memory is held in mind—the hold period), a 1 s epoch from the midpoint of the hold period and an epoch 1 s before the end of the hold period (4 s into holding a memory in mind). Not shown here, but especially interesting, is a powerful negative-going wave from frontal to posterior regions which occurred shortly after the manual response. Conway et al. (2001) termed this a Memory Engagement Potential and proposed that it acted to reset the recently activated networks that formed the memory which, temporarily, were set in a state of

gradual dysfacilitation by the switch to processing mediating the execution of the manual response. This is perhaps reflected in the first plot (left side) of the lowest row in Fig. 11 which shows activation contracted to frontal and motor regions. The middle plot in this row and final plot both show the reestablishment of the pattern of activation present at the midpoint of retrieval. This is a pattern in which foci of activation are distributed through networks in left prefrontal cortex and posterior occipital networks. Activation was found to be strongest in right occipital networks. Note also, that activation in right posterior temporal regions was stronger than activation in the corresponding left posterior temporal regions. This pattern is the neurophysiological signature of forming and holding a specific autobiographical memory in mind. It shows the gradual interlocking of control processes with the autobiographical memory knowledge base and especially sensory-perceptual episodic memories which appear to be located in occipital areas. This interlocking task took place over a period of several seconds during which generative retrieval operated. It is the dynamic and extended pattern of activation predicted by the SMS framework and fully reflects the neurological complexity of autobiographical remembering.

Neuroanatomy

EGG provides good temporal resolution but relative to fMRI and PET comparatively poor spatial resolution. Our detailed knowledge of the critical neuroanatomical sites that mediate autobiographical remembering derives mainly from fMRI studies. However, as Conway et al. (2002) point out in an extended evaluative review many of these studies have methodological flaws that greatly reduce the generality of their conclusions. For instance, Conway et al. (1999) in an early PET study of autobiographical remembering allowed only 5 s for memory retrieval. This was to ensure retrieval of sufficient memories in the 90 s window of scanning time. In retrospect we discovered that this simply had not been long enough and many participants failed to form specific memories on many of the trials. In one sense this proved to be of interest as all participants had at least attempted to form memories to each cue word and we had, therefore, a good study of the retrieval phase of autobiographical remembering. The main finding of this study was very extensive left prefrontal activation which is highly consistent with the left prefrontal activation shown in Fig. 11.

Despite methodological problems with many neuroimaging studies that aimed to investigate the neurological basis of autobiographical remembering, and the almost complete absence of replications, there are now numerous studies and some consensus amongst the findings. Addis (2005) provides the most comprehensive review to date. Key regions identified in this review are the medial prefrontal cortex, anterior thalamus, temporal pole, medial temporal lobes (MTL), retrosplenial/posterior cingulate regions, precuneus, temporoparietal junction and cuneus. It is these areas which in most studies have been found to be highly active during the construction of specific autobiographical memories. Exactly the type of distributed network that could give rise to the pattern of activation we detected in our EEG study and which is shown in Fig. 11. Importantly, however, is what appears to be the increasingly central role of the MTL and in particular the hippocampal formation (for recent studies, see for example, Addis, Moscovitch, Crawley, & McAndrews, 2004; Gilboa, Wincour, Grady, Hevenor, & Moscovitch, 2004 Graham, Lee, Brett, & Patterson, 2003). One possibility here is that during retrieval hippocampal networks may act to mediate the connection between anterior systems and posterior networks. In the SMS model this would be a connection between autobiographical knowledge and episodic memories. Conway (2001) argued that fronto-temporal networks mediate the connection of working self-processes to the autobiographical knowledge base which itself is distributed in temporal lobe networks, especially the MTL. Neuroanatomically then generative retrieval might be mediated by interlocking networks which extend from frontal, through temporal, and via MTL and hippocampal networks, to occipital and other posterior sites, i.e., retrosplenial networks.

Two memory systems? An evolutionary hypothesis

Findings from neuroimaging have enriched the study of autobiographical memory and both confirmed and helped to develop thinking about this complicated form of higher order cognition. Overall these findings as well as the other findings covered in earlier sections suggest a hypothesis concerning the evolution of memory. The hypothesis is this: there are two memory systems one phylogenetically older than the other. The older memory system is episodic memory. This an image based correspondence system that has little in the way of conceptual organization and which is mainly specialized for recent memories. It is a system that evolved to support adaptive short-term goal processing and is cue driven. In neuroanatomical terms it is a posterior temporo-occipital system. It is a system that would allow most species to operate effectively in their environment day-by-day. The more recent system is knowledge based and conceptually organized. It provides an organizing context for episodic memory. In a sense it 'sits' on top of episodic memory and provides an access route that locates memories and set of memories in meaningful ways for the self. It is a system in which coherence is the dominant force and it is specialized to support long-term goals. I

suggest that the knowledge-based system is, neuroanatomically, a prefrontal anterior-temporal system (in which temporal pole networks are critical). In this scheme the hippocampus might function as a major bridge between the fronto-temporal and temporo-occipital memory systems.

This two systems memory view has some interesting predictions. A major one is that organisms who do not have the more recent system, or who have only an attenuated version of it, will not be able to engage in long-term planning. Thus, many animals that appear to have something like episodic memory such as birds, dogs, and other animals who can for example horde food and return considerable periods of time later to find that food (see Clayton, Griffiths, Emery, & Dickenson, 2001), nonetheless cannot engage in the long term pursuit of goals. And this is because they lack the more recent fronto-temporal memory system. The same may be true of infants who are in the process of developing this system. Patients with anterograde amnesia, who have a severely disrupted memory system, are also impaired in executing long-term goals (see Tulving, 2002). Finally, the two systems can exist independently of each other. We have already seen that some amnesic patients often retain extensive amounts of conceptual autobiographical knowledge while having little in the way of episodic memory (Conway & Fthenaki, 2000). Conversely in semantic dementia episodic memories exist for items of knowledge of which the patient no longer has any conceptual knowledge (Hodges & Graham, 2001, review the growing body neuropsychological evidence in this area).

Episodic memories that exist without conceptual knowledge and can, perhaps, still be of value in that they can provide information about recent goal processing. A speculative suggestion from the SMS perspective is that episodic memories are formed from the very earliest points in life and act as the building blocks of conceptual knowledge (this theory was originally proposed by Nelson, 1974). Within the SMS framework episodic memories are viewed as phylogenetically and ontogenetically earlier than conceptual autobiographical knowledge. This is a conjecture that runs counter to Tulving's thinking about the development of episodic memory (see Tulving, 2005). Tulving argues for the late phylogenetic and ontogenetic development of episodic memory and for the case that episodic memory is a uniquely human mental ability. The goal-driven, motivated cognition, view of human memory expressed in the SMS framework leads to a different conclusion. Episodic memories with the characteristics listed in Table 3 represent information about progress in short-term goal processing and this is a species-general adaptation that allows organisms to operate in an adaptive way in their environments. Conceptual knowledge about an individual's life is the later evolutionary development and it allows long-term goal processing and the emergence of a conceptual self, both which are, arguably, uniquely human characteristics.

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