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# A THEORY OF AUTOBIOGRAPHICAL MEMORY: NECESSARY COMPONENTS AND DISORDERS RESULTING FROM THEIR LOSS

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In this paper we argue that autobiographical memory can be conceptualized as a mental state resulting from the interplay of a set of psychological capacities—self-reflection, self-agency, self-ownership and personal temporality—that transform a memorial representation into an autobiographical personal experience. We first review evidence from a variety of clinical domains—for example, amnesia, autism, frontal lobe pathology, schizophrenia—showing that breakdowns in any of the proposed components can produce impairments in autobiographical recollection, and conclude that the self-reflection, agency, ownership, and personal temporality are individually necessary and jointly sufficient for autobiographical memorial experience. We then suggest a taxonomy of amnesic disorders derived from consideration of the consequences of breakdown in each of the individual component processes that contribute to the experience of autobiographical recollection.

## THE SELF

Scholarly investigations of the self can approach their subject matter from either an ontological or an epistemological perspective. The former examines the status of the self as an object of scientific and philosophical inquiry, attempting to ascertain what the self is. Theorists pursuing the ontology of self immediately find themselves immersed in a host of thorny issues about mind and body, subject and object, object and pro-

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cess, the homunculus, free will, self-awareness, and other puzzling matters (e.g., Bermudez, 1998; Cassam, 1994; Dalla Barba, 2002; Flanagan, 2002; Gallagher & Shear, 1999). The enduring nature of these problems has led some to question whether a conceptual understanding of the self is possible in practice (e.g., Olson, 1999) or in principle (e.g., McGinn, 1989).

Although deeply interested in the complex issues raised by the problem of ontology, our concern in this article is with first-person epistemology—how we come to know who and what we are. We start by taking the existence of self as an undeniable fact of human first-person experience. Despite its problematic nature as an object of analysis, the self, as Descartes famously observed (1637/1970), is beyond doubt—it is a personal truth given by virtue of its direct phenomenological acquaintance. But what is the basis of this acquaintance? In what ways do we come to know ourselves? How do we know we possess some features or characteristics but not others? Not only are these important questions, they may be analytically prior to an analysis of what the self is. As Strawson notes, the "sense of the self is the source in experience of the philosophical problem of the self. So the first thing to do is to track the problem to this source in order to get a better idea of what it is" (Strawson, 1999, p. 2).

Questions about first-person epistemology have long been a focus of scholarly inquiry. Much of this interest has been directed toward understanding the part played by memory in the experience of self (e.g., Greenwald, 1981; Grice, 1941; James, 1890; Kihlstrom & Klein, 1994; Klein, 2001; Klein, Loftus, & Kihlstrom, 1996; Locke, 1690/1731; Shoemaker, 1963; Singer & Salovey, 1993; Snygg & Combs, 1949). The basic idea is that one's sense of self depends, in a fundamental way, on memories of one's past experiences and the capacity to call those experiences to mind. One of the earliest proponents of this view, John Locke (1690/1731), maintained that a person's identity, which is to say his or her selfhood, extends to that portion of his or her past he or she can remember. Along similar lines, Grice (1941) argued that the self is constructed from the recollection of personal experiences and, therefore, "is to be defined in terms of memory" (p. 340).

The view that the sense of self arises from memory alone may be too extreme. In this article, we discuss some of the additional computational machinery that may be necessary for memory to serve as a basis for self-knowledge. Our goal is to provide an initial step toward mapping some of the psychological processes needed to transform a memory trace into an autobiographical memorial experience.

## MEMORY

Modern cognitive theories often distinguish between two forms of knowledge stored in memory: declarative and procedural (e.g., Parkin, 1993; Roediger, Weldon, & Challis, 1989; Squire, 1994; Tulving, 1995). Declarative knowledge is our fund of factual information about the world. Procedural knowledge is our repertoire of rules and skills by which we navigate the world. Conceptually, the difference between procedural and declarative memory coincides with Ryle's (1949) classic distinction between knowing how (operating on the environment in ways difficult to verbalize) and knowing that (stating knowledge in the form of propositions).

Declarative knowledge, in turn, takes two basic forms: episodic and semantic (e.g., Cohen 1984; Foster & Jelicic, 1999; Parkin, 1993; Tulving, 1983, 1995, 2002; Wheeler, Stuss, & Tulving, 1997). Episodic memory is held to consist in knowledge of a previously experienced event along with an awareness that the event occurred in one's past. For example, recalling the occasion when I arrived late for an appointment requires that I have a mental state representing the particular event of being late along with an additional representation of that event as something that happened at a previous time in my life (e.g., Gennaro, 1992; Klein, 2001, in press; Levine et al., 1998; Suddendorf & Corballis, 1997; Tulving, 1993, 1995; Wheeler et al., 1997). There is a characteristic quality to the phenomenal experience—the sense of reliving the event, that it happened to *me*—which Tulving (1985) refers to as *autonoetic awareness*.

Semantic memory, by contrast, is not accompanied by awareness of re-experiencing one's personal past: It is memory experienced as knowledge without regard to where and when that knowledge was obtained (e.g., Perner & Ruffman, 1994; Tulving 1983, 1993, 1995; Wheeler et al., 1997). Most semantic memory makes no reference to the self; it can, however, contain propositions expressing facts about the self (e.g., *I am friendly*; *I was born in New York*), just as it can about other things in the world. But this information is known in the same way that one knows that apples are edible; it is remembered but not re-experienced. Accordingly, the quality of the phenomenal experience is different, one of *knowing* rather than *reliving*, which Tulving (1985) refers to as *noetic awareness*.

## THE SELF AND AUTOBIOGRAPHICAL MEMORY

Our knowledge of self is very much tied up with the "story" of how what we have experienced has made us who we are, and how who we are has led us to do what we have done (e.g., Bruner,1997; Kihlstrom & Klein, 2002; McAdams, 1993; Nelson, 1988, 1996). Autobiographical

self-knowledge, in turn, requires a capacity to represent the self as a psychologically coherent entity persisting through time, whose past experiences are remembered as belonging to its present self (e.g., Howe & Courage, 1997; Klein, 2001; Klein, Loftus, & Kihlstrom, 2002; Nelson, 1997; Suddendorf & Corballis, 1997; Wheeler et al., 1997). Episodic memory serves this function by enabling its owner to mentally travel back in time to relive previously experienced personal events (e.g., Klein, 2001; Tulving, 1993, 2002; Tulving & Lepage, 2000; Wheeler et al., 1997). Absent this ability, a person would be unable to represent past and present states as aspects of the same personal identity, and thus be unable to know that a current mental state represents an episode or state previously experienced.

To experience memory as autobiographical self-knowledge requires, at a minimum, three capabilities:

1. *A capacity for self-reflection*; that is, the ability to reflect on my own mental states—to know about my own knowing (e.g., Frith, 1992; McCormack & Hoerl, 1999; Suddendorf & Corballis, 1997; Wheeler et al., 1997).
2. *A sense of personal agency personal ownership*; that is, the belief that I am the cause of my thoughts and actions (e.g., Bruner, 1994; Damen & Hart, 1988; Macmurray, 1957; Povinelli & Cant, 1995; Stern, 1985) and the feeling that my thoughts and acts *belong to me* (e.g., Gallagher, 2000; Humphrey, 1992; James, 1890; Vesey, 1974).
3. *The ability to think about time* as an unfolding of personal happenings centered about the self (e.g., Klein et al., 2002; McCormak & Hoerl, 1999; Robinson & Freeman, 1954; Tulving, 2002).

Models of self that emphasize reflection, agency/ownership and subjective temporality can be found in the work of Bosch (1970), Cooley (1902), Damon and Hart (1988), Damasio (1999), Gallagher (2000), Klein (2001), Stern (1985), and Vogeley, Kurthen, Falka, and Maier (1999).

In this article, we argue that episodic memory can be conceptualized as a mental state resulting from the finely tuned interplay of a set of psychological capacities that transform declarative knowledge into an autobiographical personal experience. It follows that breakdowns in any of these components (i.e., self-reflection, self-agency, self-ownership, personal temporality) should produce, in varying degrees, impairments in episodic recollection. In the next section, we review evidence that shows that this does indeed occur.

## DISTURBANCES OF THE COMPONENTS OF AUTOBIOGRAPHICAL MEMORY

### SELF-REFLECTION

Disturbances in higher-order cognitive function often accompany frontal lobe pathology. Although symptoms may vary both with the nature and location of the damage (for reviews, see Blumer & Benson, 1975; Miller & Cummings, 1999; Stuss & Benson, 1986), a consistent and prominent pathology consists in a reduced capacity to engage in self-reflection (e.g., Ackerly & Benton, 1947; Brickner, 1936; Macmillan, 1986; Stuss, 1991). In line with these clinical findings, recent neuroimaging studies suggest that the capacity to self-reflect depends critically on structures located in the frontal lobes (e.g., Baron-Cohen et al., 1994; Kelley et al., 2002; Morin, 2002: Vogeley et al., 2001; see Stuss & Anderson, in press, for a review).

Given our analysis of the relation between self-reflection and autobiographical self-knowledge, we should expect to find frontal lobe pathology accompanied by impairments of episodic memory. The literature suggests that this is often the case (e.g., Della Sala, Gray, Spinnler, & Trivelli, 1998; Della Sala, Laiacona, Spinnler, & Trivelli, 1993; Levine et al., 1998; Levine et al., 1999; Markowitsch et al., 1993; for a comprehensive review, see Wheeler, Stuss, & Tulving, 1995). By contrast, memory that does not require awareness of re-experiencing personal happenings from one's past (e.g., procedural and semantic) typically is spared (e.g., Della Sala et al., 1993; Della Sala et al., 1998; Levine et al., 1998; Levine et al., 1999; Wheeler et al., 1997).

Persons with autism also evidence limited capacity for self-reflection (e.g., Baron-Cohen, 1989, 1991; Baron-Cohen et al., 1994; Frith, 1989; Hobson, 1993; Jordan, 1989; Russell, 1996; Tager-Flusberg, 1992). Studies have shown that, compared to normally developing children, children with autism have problems reflecting on their mental states (e.g., Baron-Cohen, 1995; Tager-Flusberg, 1992). Similarly, clinical descriptions of autistic patients frequently make mention of their inability to self-reflect (e.g., Baron-Cohen, 1989; Bishop, 1993; Hobson, 1993). Persons with autism also appear to have problems with episodic recollection. Compared with nonautistic controls, autistic individuals perform significantly worse on tests of recall (e.g., Bennetto, Pennington, & Rogers, 1996; Boucher, 1981b; Boucher & Warrington, 1976; Ozonoff, Pennington, & Rogers, 1991; Tager-Flusberg, 1991), particularly when testing requires recollection of personally experienced events (e.g., Boucher, 1981a; Boucher & Lewis, 1989; Klein, Loftus, & Chan, 1999; Klein, Cosmides, Costabile, & Mei, 2002; Powell & Jordan, 1993) By con-

trast, they typically perform nearly as well as controls on tasks that rely on semantic and procedural memory (e.g., Ameli, Courchesne, Lincoln, Kaufman, & Grillion, 1988; Boucher & Lewis, 1989; Boucher & Warrington, 1976; Bowler, Mathews, & Gardiner, 1997; Goldstein, Minshew, & Siegel, 1994; Klein et al., 1999; Tager-Flusberg, 1985a, 1985b, 1991; Ungerer & Sigman, 1987; but see Klinger & Dawson, 1995).

## AGENCY AND OWNERSHIP

Pathologies of personal agency/ownership are among the hallmark symptoms associated with schizophrenia (for reviews of schizophrenic symptomology, see David & Cutting, 1994; Frith, 1992). Disturbances in personal agency are reflected in symptoms such as delusions of control and thought withdrawal (e.g., Daprati et al., 1997l; Gallagher, 2000; Frith 1992, 1996). For example, patients suffering delusion of control experience their own thoughts and actions as having been caused by an external agent rather than the self (e.g., Vogeley et al., 1999). Disturbances in the experience of personal ownership are reflected in symptoms such as thought insertion and auditory hallucinations (e.g., Frith, 1992; Vogeley et al., 1999). Thought insertion, for example, consists of patients disavowing ownership of their own thoughts, attributing them instead to an outside source (e.g., Frith, 1992).

If personal agency and personal ownership are among the prerequisites for autobiographical self-knowledge, and if schizophrenia represents a breakdown in these capacities, it follows that schizophrenics should experience impairments of episodic memory. A review of the literature shows this to be the case (e.g., Bazin & Perruchet, 1996; Berthet et al., 1997; Feinstein, Goldberg, Nowlin, & Weinberger, 1998; Huron et al., 1995; Keri et al., 2000; Lussier, Stip, & Coyette, 1997; Rizzo, Danion, Van Der Linden, & Grange, 1996; Rushe, Woodruff, Murray, & Morris, 1999). Importantly, these impairments are disproportionately pronounced in comparison to other memory deficits in schizophrenia (e.g., Bazin & Perruchet, 1996; Huron et al., 1995; Lussier et al., 1997; Rushe et al., 1999), suggesting that episodic memory loss is not simply part of a pattern of general mental deterioration.

## THE SENSE OF PERSONAL TEMPORALITY

Episodic memory differs from other forms of memory in that it alone enables one to mentally travel through subjective time to relive personal events from one's past. If a precondition for "mental time travel" is the

capacity to become aware of the temporal dimensions of one's own experience, it follows that an individual suffering impairments of personal temporality should find it difficult to experience declarative knowledge as part of his or her past.

Although very few studies have examined the effects of pathologies of subjective temporality on memory, those that have generally are supportive. One source of evidence comes from the case of patient D.B., who suffered brain damage as a result of anoxia following cardiac arrest (Klein, Cosmides, Costabile, & Mei, 2002; Klein, Kihlstrom, & Loftus, 2002). Neuropsychological assessment of D.B.'s temporal orientation (Mini-Mental States Examination (MMSE); Cockrell & Folstein, 1988, and General Practitioner Assessment of Cognition ( GPCOG); Brodaty et al., 2002) showed severe disorientation with respect to the present. For example, he did not know the day of the week, the current year, or even his age. Additional testing revealed that D.B. was unaware that he had a past and unable to imagine what his experiences might be like in the future. Not surprisingly, D.B.'s episodic memory is severely impaired: he cannot consciously bring to mind personal experiences from any point in his past.

A severe disturbance of temporality also is found in the case of patient K.C. (for reviews, see Tulving, 1985, 2002). For example, when asked by his physician what he did "before coming to where he is now, or what he did the day before, he says he does not know. When asked what he will be doing when he leaves 'here,'or what he will be doing 'tomorrow,' he says he does not know" (Tulving 1985, p. 4). Although K.C. shows disturbances in his thinking about past and future, he can function in the present moment within some kind of psychologically constructed event boundary. He is able to play a hand of bridge, for example, as long as nothing interrupts the bidding. Yet he forgets what happened if a phone rings in midplay. K.C.'s amnesia is profound: He is unable to consciously bring to mind a single personal experience from any point in his past.

Admittedly, while these findings support the hypothesis that disruptions of personal temporality compromise episodic memory, they also could support the argument that impairments in episodic recollection result in pathologies of personal temporality. However, a review of the literature reveals that episodic memory loss is not necessarily associated with impairments of temporal consciousness. For example, patients with retrograde amnesia cannot remember their personal past, but they can remember events occurring after the brain trauma that left them amnesic; other amnesic patients report other types of temporal gaps in their personal narrative. Yet there is no evidence to suggest that these impairments invariably lead to disruptions in the experience of the personal

present and future (for example, see Broman, Rose, Hotson, & Casey, 1997; Kitchener, Hodges, & McCarthy, 1998; Stuss & Guzman, 1988). Even in severe cases of episodic memory loss covering a person's entire life (e.g., Ahern, Wood, & McBrien, 1998; Gadian et al., 2000; Vargha-Khadem et al., 1997), individuals so afflicted appear capable of appreciating the present and anticipating their future. What we are arguing, then, is that patients such as K.C. and D.B. suffer primarily from a disruption of personal temporality, and that as a result of this pathology they are rendered unable to experience mental states as autobiographical (for a similar interpretation, see Dalla Barba, 2002 and Tulving, 1985).

An additional perspective on the relation between temporality and autobiography is provided by the literature on mirror self-awareness (for reviews, see Anderson, 1984; Lewis & Brooks-Gunn, 1979; Parker, Mitchell, & Boccia, 1994). Research indicates that most children are able to recognize themselves in a mirror by approximately 2 years of age, suggesting that they have the ability to treat the self as an object of their attention (i.e., to self-reflect). Awareness of self as temporally extended, however, does not fully develop for another 2 years (e.g., Nelson, 1997; Perner & Ruffman, 1994; Povinelli, Landau, & Perilloux, 1996; Suddendorf & Corballis, 1997).[1]

A set of studies by Povinelli and colleagues (Povinelli et al., 1996; Povinelli & Simon, 1998) nicely illustrates these developmental changes in children's temporal self-awareness. In one study, 2-, 3-, and 4-year old children were covertly marked on the forehead with a sticker while being videotaped. The tape was played back to each child about 3 min later. None of the 2-year-olds and only 25% of the 3-year-olds reached up to remove the sticker when shown the tape. In contrast, 75% of the 4-year-olds reached up to remove the sticker. This is not because 4-year-olds care about their appearance whereas younger children do not. When delayed video presentation was replaced either by a mirror or by live video, the majority of the children who earlier had failed the delayed self-recognition test reached up to remove the sticker. These findings suggest that while cognitive abilities necessary for mirror self-recognition (e.g., self-reflection, a sense of personal ownership and

1. Moreover, at about the same time, children begin both to produce pretend play themselves—e.g., knowingly distort reality—and interpret the pretend acts of others. This suggests that they have available a distinction between self and other that can be made explicit in different representations of these cases of pretense—for example, "I pretend that" versus "*Mother* pretends that" (e.g., Leslie, 1987, 1994a).

agency; Povinelli, 1995) are in place by age two, a more sophisticated conception of self as extended in time continues to develop across the preschool period (for reviews, see Povinelli, 1995; Suddendorf & Corballis, 1997).

If a sense of "self through time" does not emerge until about age four, it follows that episodic memory should not be available to children prior to their fourth year. The literature largely supports this hypothesis: Although very young children can show evidence of memory for specific events, locations, and activities in their lives (e.g., Fivush & Hudson, 1990; Nelson, 1996; Rovee-Collier, 1997), these memories often seem more like semantic self-knowledge than episodic recollections of experiences on which that knowledge is based (e.g., McCormack & Hoerl, 1999; Nelson, 1993, 1996; Suddendorf & Corballis, 1997). Clear evidence of episodic recollection—the ability to recognize a current mental state as a representation of a previous experience in one's life—is not reliably found until approximately age four (e.g., McCormack & Hoerl, 1999; Nelson, 1988, 1997; Povinelli et al., 1996; Welch-Ross, Fasig, & Farrar, 1999; but see also German & Leslie, 2000).

Neuropsychological impairments seldom are pure with respect to the cognitive mechanisms they affect. Nonetheless, the data we have reviewed, while far from perfect, exhibit sufficient specificity to permit some insight into the operation of component systems in relative isolation. For example, amnesic patient D.B., who suffered severe pathology of personal temporality, has no obvious impairments with regard to self-reflection, personal agency, or personal ownership. Patients suffering frontal lobe pathology show deficits in the capacity to self-reflect, but their sense of agency and ownership typically is spared. Schizophrenia entails severe pathologies of personal agency and ownership, but personal temporality and the capacity to self-reflect are largely spared (although the contents of self-reflection can be seriously distorted as a consequence of breakdowns in ownership and agency). Despite diverse profiles of impairment, a common factor among these pathologies is that each presents a diminished capacity to mentally remember events and experiences from the personal past. This implies the conclusion that self-reflection, agency/ownership, and personal temporality are individually necessary and (perhaps) jointly sufficient for autobiographical memorial experience.

## IMPLICATIONS FOR AUTOBIOGRAPHICAL MEMORY

The findings reviewed support the conclusion that a number of psychological capacities—the ability to self-reflect, a sense of personal agency/ownership, and an awareness of the self as being situated

within a temporal framework—are involved in the transformation of declarative knowledge into an autobiographical memorial experience. On this view, episodic retrieval—the generation of autobiographical memorial experiences—cannot occur unless *all* of these capacities are intact. Possessing an intact database of event memories is necessary for episodic retrieval, but it is not sufficient.

Amnesia is the inability to retrieve episodic memories. When the database of event memories has been damaged, amnesia should occur. But if the view outlined above is correct, there should be several distinct amnesic syndromes, each associated with damage to a different component of the system necessary for re-experiencing these autobiographical events. Even if the database of events is intact, amnesia could result from damage to the ability to self-reflect, damage to the machinery that creates a sense of personal agency/ownership, or damage to the sense of temporality. Brain trauma, disease, or developmental disorders could, in principle, damage one of these components while leaving the others intact. Different amnesic syndromes should result, each characterized by a different pattern of episodic memory impairment, depending on which component (or set of components) is damaged (e.g., Klein, Cosmides, Tooby, & Chance, 2002).

Before discussing these predictions, we first consider whether self-reflection, personal agency/ownership, and temporality reflect the operation of a single system, or can be considered functionally distinct components, capable of independent breakdown.

## METAREPRESENTATIONS AND AUTOBIOGRAPHICAL SELF-KNOWLEDGE

With the rise of the cognitive sciences, various components of the self began to be conceptualized as computational systems and the databases they access. For example, research on theory of mind reframed the ability to "reflect upon the self" as the ability to form metarepresentations, which are representations about other mental representations, whether one's own or others' (Baron-Cohen, Leslie & Frith, 1985; German & Leslie, 2000; Leslie, 1987). In Leslie's (1987, 2000b) account, these *M-representations* are data files with a particular format, including slots for an *agent* (e.g., "I," "You," "Dad," "Ellen"), that agent's *attitude* toward a proposition (e.g., "believe," "doubt," "hope," "remember"), and an embedded proposition (e.g., "it is raining," "I became anxious at the zoo," "I thought that modern art is ugly") (see Figure 1).

Because the agent can be the self and the embedded proposition can itself be a metarepresentation about the self, this data format allows the formation of self-reflective representations, such as "I remember that I

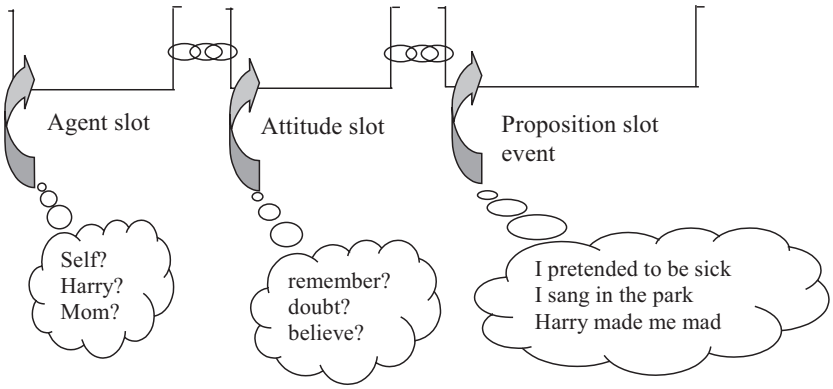


FIGURE 1. Hypothesized data format for the M-representation, consisting of three slots and the links between them (after Leslie & Thaiss, 1992). The M-representation is a "file" in the language of thought that represents information about an agent (self, Harry, Mom); the agent's mental state (i.e., propositional attitude: remember, hope, believe..); and a representation of a state of affairs that the agent remembers, doubts, believes, etc. When information is represented in this data format it is "decoupled" from semantic memory; that is, inferences can be made about the content of the agent's mental states without them conflicting with or being stored as "true" in semantic memory (Leslie, 1987, 1988). Complementary mental machinery inserts the appropriate concept into each slot, resulting in representations—some autobiographical—such as [Self]-[remembers]-[I sang in the park]. It remains an open question whether the proposition slot is restricted to propositional representations or whether it can also take event memories that have quasi-perceptual qualities.

became anxious at the zoo" or "I doubt that I thought that modern art is ugly." On this view, English expressions of this kind are generated by attaching lexical items to data files in the language of thought: M-representations whose slots are filled in as follows: [*Agent*: *Self*]-[*Attitude*: *remember*]-[*Proposition*: *I became anxious at the zoo*] and [*Agent*: *Self*]-[*Attitude*: *doubt*]-[*Proposition*: ([*Agent*: *Self*]-[*Attitude*: *thought*]-[Proposition: *modern art is ugly*])].

## M-REPRESENTATIONS AND SEMANTIC MEMORY

According to Leslie (1987, 1994a, 2000a), storing a proposition in an M-representation decouples it from semantic memory. Decoupling pre-

vents the corruption of databases in semantic memory while still allowing useful counterfactual inferences to be drawn. On this view, the purpose of semantic memory is to store information about the world that is true—or at least consistent enough with reality to effectively guide behavior. This encyclopedia of world knowledge will be less useful to the extent that it becomes corrupted with false or misleading information. Leslie argues that the specialized data format of the M-representation has an important function: It allows useful inferences to be made while preventing false information from being stored as true in semantic memory. For example, let's say you know (as a matter of semantic knowledge) that Ellen's class is on Tuesday, but you hear her say that it is on Wednesday. By embedding her stated belief —*Ellen's class is on Wednesday* —in the M-representation *Ellen believes Ellen's class is on Wednesday*, you can make inferences about Ellen's behavior (e.g., if no one tells her otherwise, Ellen will miss her class) without becoming confused as to the true state of affairs. An architecture capable of decoupling is necessary for any form of counterfactual or suppositional thinking; without it, we would be incapable of hearing fiction, making plans, or generating as-yet-unconfirmed hypotheses without becoming delusional. Delusions are false beliefs: Without decoupling mechanisms that keep some information distinct from the semantic knowledge database, stories, plans, speculations, pretenses, and falsehoods would be stored as—and therefore confused with—real events and facts (for discussion and extensions, see Cosmides & Tooby, 2000).

## M-REPRESENTATIONS AND SELF-REFLECTION

The computational machinery that produces metarepresentations appears to come on-line at about 18 months, when toddlers begin to produce and understand pretend play (e.g., Baron-Cohen, 1995; Leslie, 1987), and it can be selectively impaired. For example, individuals with autism understand that photos—physical representations of the world—can misrepresent the facts, but have difficulty understanding that beliefs—mental representations about the world—can do the same (e.g., Charman & Baron-Cohen, 1995; Leslie & Thaiss, 1992). Autism, it has been argued, disrupts the development of metarepresentational machinery, either directly (e.g., Baron-Cohen, 1995, 2000; Baron-Cohen, Leslie, & Frith, 1985; Frith, Morton, & Leslie, 1991; Leslie, 2000b) or perhaps as a result of disruptions to components responsible for detection and representation of agency based on perceptual cues (e.g., Adolphs, Pears, & Siden, 2001; Baron-Cohen, 1995; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Klin, Jones, Schultz, Volkmar, & Cohen, 2002;

Swettenham et al., 1998). Similarly, schizophrenia may be a late onset breakdown of the same system (e.g., Frith, 1992; Frith & Frith, 1991; Langdon, Davies, & Coltheart, 2002). If true, then the ability to reflect on one's own mental states should be impaired in both disorders, which appears to be the case (e.g., Baron-Cohen, 1995, Frith, 1992).

If episodic retrieval requires self-reflection, and self-reflection is made possible by metarepresentational machinery, then breakdowns in this machinery should result in amnesia (Cosmides & Tooby, 2000). As discussed above, this appears to be true: Schizophrenia and autism both cause forms of episodic amnesia (although with some important differences; see below).

## M-REPRESENTATIONS AND PERSONAL AGENCY/OWNERSHIP

The M-representation may also generate a sense of personal agency and/or ownership of one's own thoughts and actions (e.g., Frith, 1992; Frith & Frith, 1991; Langdon et al., 2002). The concept that fills the agent slot must be a representation of an agent, but this can include the concept *Self*. For example, when the agent slot is filled with the representation *Self* and the attitude slot is filled with *remember*, the event represented in the proposition would be experienced as one that happened to or was perceived by oneself—i.e., an autobiographical, episodic memory. But the mental state filling the attitude slot is important as well: If, while watching the Rose Parade, your parents tell you that they took you to see it when you were 2 years old, you might generate the self-reflective M-representation *I-know-that[the Rose Parade is pretty]*. But *knowing* is a different mental experience from remembering: *I-remember-that[the Rose Parade is pretty]* is episodic, and experienced as first-person knowledge accompanied by autonoetic qualia.

The same perspective applies to willed actions (as opposed to habitual, automatic, or stimulus-driven ones; Frith, 1992). When *Self* fills the agent slot and *intend* fills the attitude slot, then a motion represented in the proposition slot is experienced as volitional, as having been willed by the self: *I-intend-that[I stand up]*. If, through a dissociative disturbance, the agent slot is filled with an agent other then the self, then the action will be experienced as having been caused by someone else: *The hypnotist made me stand up*. If the agent slot is unfilled, one might experience an action as just happening to oneself (as when one is lying in bed in the morning and then suddenly finds oneself on one's feet, without being aware of having formed the specific intention to get up).

On this view, the concept *Self* that can fill the agent slot is a reliably developing aspect of the cognitive architecture, quite possibly one that cannot be decomposed into smaller conceptual units. In this framework we characterize it as the concept $\text{Agent}_{\text{self}}$ by structured relationships to other concepts and by the way it interacts with various components of that architecture (such as the agent slot of the M-representation). This may explain why attempts to analyze the concept *Self* into component concepts are notoriously difficult. Descartes himself was bedeviled by this problem: "*I* think therefore *I* am" presumes that which it seeks to prove—*I* appears in the antecedent clause, as well as in the consequent clause. Above, our gloss on each cognitive component that contributes to the experience of autobiographical memory could not avoid reference to a self-concept: Self-reflection was "the ability to reflect on *my own* mental states—to know about *my own* knowing"; personal agency was the experience that "*I* am the cause of *my own* thoughts and actions," personal ownership "the feeling that *my* thoughts and actions belong to *me*," temporality "an unfolding of *personal* happenings centered about the *self*". None of these experiences, which are presumed to contribute to the experience of episodic memory, can be glossed without referring to the *self*.

## M-REPRESENTATIONS AND TIME

The notion that there is an agent concept *Self* that is a conceptual primitive is worth exploring cognitively. We would argue, however, that the self as experienced is produced not merely by this concept, but by all of the machinery with which it interacts. This would include (minimally) the M-representation and representations of time.

Although it has been suggested that a temporal element be introduced into the M-representation (Cosmides & Tooby, 2000), this would not be sufficient to explain the sense of personal temporality. The capacity to think about time as an unfolding of personal happenings centered about the self implies an *ordering* of M-represented episodes, a re-living of experiences in relation to one another. Without temporal ordering, it would be impossible to structure these experiences into a narrative of one's life. In what follows, we will treat the machinery that creates temporality as something that can operate on M-representations, instead of as a subcomponent of an M-representation.

Above, we discussed how disruptions to the machinery that supports M-representations and temporality could cause breakdowns in the ability to self-reflect and disturbances of the sense of personal agency/own-

ership. Below, we discuss the various types of amnesia and other disturbances of episodic memory that such disruptions could cause.

## SPECIES OF AMNESIA

Inspection of Figure 1 shows that the M-representation is composed of (at least) three subcomponents—the agent slot, attitude slot, and proposition slot—as well as the links between them. This suggests that there are a number of distinct ways in which this data file format can break down:

1. Any of the three slots could be damaged.
2. Any (or all) of the links between the slots could be damaged.
3. The machinery that fills the slots could be damaged.
4. Some (or all) of the concepts that can fill the slots can be damaged.

For example, disruption of the agent slot or the machinery that fills it would result in a disruption in the sense of personal agency/ownership. Disruption of the attitude slot would disconnect agents from the content of their thoughts. The failure of a particular mental state concept to develop could result in a disconnection syndrome that disrupts the formation of some M-representations but not others. Failure of decoupling (resulting from any of the above) could create delusions. Machinery that creates temporality, in conjunction with intact M-representations, would create a different pattern entirely.

In this view, episodic memory impairment, including amnesia, would not be a single disorder caused by the loss of a database of event memories, but a heterogeneous set of disorders, each with a different symptom profile. As a thought experiment, we consider what kinds of impairments in autobiographical self-knowledge would result if there were damage to only one of the components hypothesized to contribute to the experience of an episodic memory.

1. *Damage to the database of events*. Classic amnesic syndrome is usually assumed to involve damage to a database of episodic event memories (e.g., Cremak, 1984; Parkin, 1997; Tulving, 1983). Head trauma, for example, can cause a retrograde amnesia: The person cannot remember events that happened before the accident, but has no trouble remembering events that happened afterward. In these cases, there is no obvious disturbance in the ability to self-reflect, in the sense of personal agency/ownership, or in temporality (events occurring after the accident are remembered in correct temporal order). That is, the machinery

to form M-representations appears entirely intact, along with the sense of temporality, and there are no impairments to other memory systems (working memory, semantic memory, procedural memory, the perceptual-representational system; see Klein et al., 2002, for a review). This profile of spared and impaired abilities is consistent with the notion that a portion of a database of event memories has been destroyed. This is the profile that most often comes to mind when one thinks of episodic amnesia. But the perspective above suggests that there will be other forms, associated with damage to the other systems that cooperate in creating autobiographical self-knowledge.

2. *Disruptions of the agent slot of the M-representation*. Imagine that the machinery that fills in the agent slot is disrupted. The agent slot provides a source tag: It specifies which individual—the self or someone else—remembered, believed, doubted, etc., the proposition or event in question. These source tags might be important both at encoding and at retrieval. If the agent tags get scrambled, then thoughts generated by the self will be attributed to other individuals and vice versa.

Schizophrenia (along with other dissociative disorders) is particularly interesting in this regard. Schizophrenia disrupts the experience of personal agency/ownership, without necessary affecting one sense of temporality. When an individual with schizophrenia "hears voices," they are not experienced as in the outside world: The thoughts are "heard" inside the individual's own head. As the Friths (e.g., Frith, 1992) have argued, this is consistent with the hypothesis that there has been damage to the machinery that fills the M-representation's agent slot (or damage to the slot itself): Thoughts, intentions, and memories generated by the individual are attributed to other agents during positive symptoms of schizophrenia, or to no agent at all, as the disease progresses and periods of negative symptoms become longer and longer.

As the machinery that inserts agents into the agent slot breaks down—or as the slot itself breaks down—all thoughts would be experienced noetically, none autonoetically. This means that opinions and beliefs, whether true or false, would be retired to semantic memory as true, corrupting the individual's database of world knowledge with false or misleading information (e.g., Cosmides & Tooby, 2000; Leslie, 1987, 1994a). It also means that the person would appear to have an episodic amnesia: At retrieval, events that happened to the individual would be experienced as facts of the world, not as personal memories.

As in classical amnesia, there would be no damage to working memory, procedural memory, or the perceptual-representational memory (e.g., Klein et al., 2002). However, when memory traces of events are re-

trieved in an M-representation to produce an episodic memory experience, the agent slot might be incorrectly filled. This could produce the following profile of episodic memory effects:

(a) If another agent is inserted rather than the self, then an event experienced by the schizophrenic individual would be *recalled* as having happened to someone else; one would experience oneself as telepathically "remembering" someone else's memories. Intentions generated by the individual will be experienced as having been generated by someone else: Someone else will seem to controlling one's actions, and this "external control" will be *remembered* as such.

(b) If the self is inserted inappropriately, one might "remember" having participated in events that are fictional or were described to one by others. After reading *The Lord of the Rings* or seeing the movie, one might vividly "remember" visiting the Shire with Frodo, a memory trace that was not derived from first-person experience.

(c) If no agent was inserted into the agent slot, thoughts and memories originating in the individual will not be experienced as first-person knowledge, that is, as ideas or events that were experienced directly by the individual. They will be experienced instead as facts about the world. In this situation, the person will have difficulty recalling any episodes as having happened to the self. Moreover, thoughts and opinions will be stored in semantic memory (whether true or not). The individual's database of knowledge will slowly accumulate false information and become increasingly discrepant with the knowledge of others. Impairments to the database of nonpersonal semantic knowledge is relatively rare in classic amnesic syndrome due to head injury, but these do occur in schizophrenia (McKenna, Mortimer, & Hodges, 1994).

The first two effects, (a) and (b), are typical when an individual with schizophrenia is experiencing positive symptoms; they make the person's autobiographical self-knowledge appear false or delusional. But as the disease progresses untreated, and periods of so-called negative symptoms predominate, the profile is more consistent with the situation described in (c), where no agent is inserted at recall. Eventually the person seems simply amnesic, with some distortions in semantic knowledge. An individual with schizophrenia need not be disoriented as to time. However, their personal narrative might have holes (due to the amnesia). Moreover, if the content of memory traces is used to reconstruct the temporal order of past events (e.g., remem-

bering that personal event occurred after Reagan was elected but before Clinton), then a schizophrenic individual's personal narrative could show some temporal distortions as the contents of their memories stray farther from reality.

In this view, disorders of the agent slot in schizophrenia will result in several different patterns of episodic memory impairment: Delusions (a and b) and episodic amnesia (c) reflect the presence of slightly different kinds of impairment to the same piece of cognitive machinery.

3. *Disruptions of a propositional attitude*. There is evidence that autism interferes with the development of mental state concepts that are epistemic: ones involving knowledge states such as *know*, *believe*, *remember*, *think*, *doubt*, *pretend* (as opposed to those involving perceptual states [saw, heard] or goal states [want, desire], Baron-Cohen, 1989; Tan & Harris, 1991). At the same time, there is no evidence that individuals with autism lack an agent concept for *Self* or others, their IQs can be normal or even high, and they have no obvious impairments to their sense of personal temporality. They do, however, have problems with joint attention, which might be attributed to an inability to form certain M-representations: ones in which the embedded proposition is a representation of a person's attention toward another object (e.g., I see that Mom attends to the cookie; see Baron-Cohen, 1995). What implications should this have for episodic memory? We noted above that autism seems to produce episodic impairments, but what, exactly, should the profile look like?

Epistemic mental state concepts are those that are uploaded into the attitude slot of the M-representation. If these fail to develop, then it would be difficult to reflect on one's own beliefs or those of others: There would be a failure of a certain kind of self-reflection. More to the point, remember is an epistemic mental state: To say you *remember* something is to imply that it really happened. If this mental state concept fails to develop, M-representations such as *I remember that the Rose parade is pretty* should be impossible to form (along with other epistemic ones, such as *I think the Rose Parade is pretty, I doubt the Rose Parade is pretty,* and *I pretended that the Rose Parade is pretty*). Failure to develop these concepts would result in what amounts to a disconnection syndrome: *I ____ that the Rose Parade is pretty* would not support the autonoetic experience of *remembering*. It is difficult to see how one could represent retrieved episodes as having happened to the self-as-agent without being able to represent what the self's propositional attitude toward the event was (did I *remember* it? *imagine* it? *doubt* it? *plan* it but not do it? etc).

The result would be a form of amnesia particular to knowledge states. The autistic individual should have difficulty experiencing himself or

herself as *remembering* past events. This should be most severe when it is knowledge states that must be remembered (*I remember that I once believed in angels*), as both propositional attitudes in this second-order M-representation are epistemic. The pattern for past goal states might be slightly different, as there is some evidence that mental state concepts such as *want* or *desire* might develop properly in autism (e.g., Baron-Cohen, 1991; Carpenter, Pennington & Rogers, 2001; Tan & Harris, 1991; see also Phillips, Baron-Cohen & Rutter, 1998; Russell & Hill, 2001 for extended discussion). In this view, a representation that one has a goal (e.g., for ice cream) could be formed, but when retrieved, however, it should be *experienced* more as a matter of fact than as a personal reminiscence. That is, it should not be experienced autonoetically, as a reliving of the moment—which is the quality of experience that accompanies the generation of the M-representation *I remember that I wanted ice cream*.[2]

The disruptions of episodic memory in autism should resemble the profile of (c) above for schizophrenia, but the phenomena described in (a) and (b) should not occur (experiencing another person's memories, "remembering" fictional events, etc.). This is because schizophrenia is thought to involve a disruption to the agent slot, whereas autism is not.

As discussed above, there is evidence that individuals with autism have difficulty recalling episodes from their personal past. There also is evidence of eccentricities of semantic memory (e.g., Klein, Cosmides, Costabile, & Mei, 2002), as Leslie's theory of the function of decoupling in preventing corruption of semantic memory predicts. Tests have not yet been done to determine whether the more nuanced profile, with especially profound amnesia for knowledge states compared to goal states, occurs.

4. *Disruptions of the concept of Self*. In principle, it should be possible for the concept *Self*, which can fill the agent slot of the M-representation, to be damaged by disease or trauma. A person lacking any agent concepts—for either self or others—might well present as a very severe case of autism: If agents cannot be inserted into an M-representation, then agents cannot be represented as having mental states of any kind, in-

2. We note that as a matter of fact, it is an open empirical question concerning whether systems for representing 'goals and perception' are to be thought of as requiring M-representational machinery (as is assumed for the calculation of epistemic states such as belief, knowledge and pretense), or are handled by prior systems within the overall architecture of the mental state reasoning system (see Leslie, 1994b for extended discussion). Either outcome can be accommodated within the current framework, though a full treatment of this issue is beyond the scope of the present paper.

cluding goal states or perceptual states. Such a person would be totally unable to remember a personal past. Although patients with Alzheimer's disease do seem to have a self-as-agent concept in the early and middle stages of the disease (e.g., Klein, Cosmides, & Costabile, 2003), the very latest stages, in which the patient does not seem able to remember or even identify family members or themselves (e.g., Hehman, German, & Klein, in press), may involve a breakdown in these agent concepts.

There may be certain drugs that temporarily disrupt the Self agent concept. Although it is difficult to know how to analyze reports of phenomenal experiences, the hallucinogen Dimethyltryttamine (DMT) sometimes is experienced as breaking down any sense of a self as existing in space and time (e.g., Shanon, 2002; Strassman, 2001). Moreover, temporarily attaining this experiential state is the goal of certain meditative traditions.

5. *Disruptions of temporality*. Imagine a person who has intact M-representations, intact agent concepts, and an intact database of event memories. However, the machinery of temporality is disrupted, such that the person cannot order retrieved memories with respect to time, nor distinguish past from present. An individual with this pattern of impaired and spared abilities would present a distinctive profile of episodic memory impairment. Such an individual might be able to remember events from a personal past, but would be deeply confused as to when things happened. Events that happened years ago might be remembered as having happened last week, and vice versa.

The amnesic patient D.B. has no obvious impairments with regard to self-reflection, personal agency, or personal ownership (e.g., Klein, Rozendal, & Cosmides, 2002). He did, however, suffer severe pathology of personal temporality (and may have also sustained some damage to his database of event memories). In response to prompts, he usually was unable to recall episodes from a personal past. On occasion, however, he did accurately recall events, but with wildly incorrect time assignments (Klein, Loftus, & Kihlstrom, 2002). For example, D.B. recalled having visited with friends from the East Coast during the prior week, an event that his daughter reports happened 41 years ago. And he incorrectly "remembered the future": in the past, he had driven down the coast with his parents (now dead), yet he reported this as a future plan "I will be driving down the coast with my parents soon". Time confabulations of this kind also occurred in K.R., who had midstage Alzheimer's disease (Klein et al., 2003).

6. *Disruptions of inhibitory control*. Although the M-representation and decoupling may be necessary for orderly self-reflection, other mecha-

nisms are also required. For example, Leslie (2000b) argues that believing what is true is a prepotent response, which must be inhibited in order to form an M-representation that reflects the fact that someone else holds a false belief. The ability to coordinate action and inhibit prepotent responses increases as the frontal lobes mature (e.g. Gerhstadt, Hong & Diamond, 1994) and decreases with frontal lobe damage (e.g., Archibald, Mateer, & Kerns, 2001; Lhermitte, 1983). Leslie and colleagues (German & Leslie, 2000; German & Nichols, 2003; Leslie, 1994b, 2000b; Leslie, German & Pollizi, in press; Leslie & Pollizi, 1998; see also Bloom & German, 2000) propose that inhibitory control must be present, alongside M-representations, for children to calculate correctly the contents of false beliefs (see also Carlson & Moses, 2001; Carlson, Moses & Breton, 2002).

This implies that damage to inhibitory control could result in another species of episodic memory impairment, even when metarepresentational machinery, temporality, and a database of events is intact. A person who lacks inhibitory control but nothing else might be able to retrieve episodic memories but unable to weave them together into a coherent narrative of his or her life story (e.g., Young & Saver, 2001). As the semantic content of one retrieved episode cues some other thought or episode, the episodes would come tumbling out one after the other in a disorderly way. Remembering an episode that occurred yesterday might cue the content of an episode from childhood, which in turn cues an episode from last year, which cues an episode from adolescence, and so on. In each case, the individual would be able to accurately report *when* the event happened (in childhood, adolescence, adulthood, etc.). However, the individual would have great trouble telling the *story* of his or her life, of stringing the events of his or her personal past together into a coherent, temporally ordered narrative life that another person could follow.

7. *Damage to multiple systems*. One problem with neurological evidence, from the investigator's point of view, is that disease, developmental disorders, or brain damage often impair multiple mechanisms. For example, persons with frontal lobe damage may show disturbances in personal temporality (although not to the degree evidenced by patients K.C. and D.B.; for review, see Damasio, 1985; Robinson & Freeman, 1954); patients with autism sometimes evidence a diminished sense of personal agency and ownership (e.g., Bosch, 1970; Hobson, 1993); and schizophrenics may eventually develop difficulties with inhibitory control (Langdon et al., 2002).

We have argued that a number of different cognitive components are necessary for autobiographical recollection, with its distinctive

phenomenological tone, to occur. Above, we tried to illustrate what profile of episodic memory impairment would occur if one—and only one—component of the several necessary for producing these recollections were impaired. Although there may be few pure cases of this kind, our hope is that the taxonomy of amnesic disorders outlined above may help clinicians identify which cognitive components are damaged in any particular case, even if there is impairment to multiple mechanisms.

There is a movement in clinical neuropsychology to move away from the characterization of "syndromes," and instead focus on identifying which mechanisms are manifesting a dysfunction and thereby causing the symptoms observed (e.g., Frith, 1992). As Frith argues, this is what happens as medical science matures: What was first identified symptomatically (e.g., "produces a fever") is eventually identified by the causal agent that produced the symptom (a strep infection, flu virus, meningitis, etc.). By identifying the causal agent, more effective treatments can be found.

We offer the above taxonomy in the same spirit. It may be a mistake to think of "amnesia" or of "episodic memory impairment" as a single, overarching syndrome. Each species of amnesia may involve episodic memory impairment, just as different pathogens can all cause a fever. However, different *profiles* of episodic impairment may occur, depending on which procedure(s) or databases are damaged.

The same multiple-systems perspective suggests that results from brain imaging should be interpreted with caution. There have been a number of attempts to locate constructs such as "autobiographical memory" in the brain (for reviews, see Nilsson & Markowitsch, 1999; Nyberg & Cabeza, 2000). But if the above perspective has any merit, then many different mechanisms participate in creating an autobiographical memorial experience. To locate a database of events in the brain, it may not be sufficient to have the control task involve retrieval of semantic knowledge. Episodic recollection may require the activation of M-representations in a way that semantic retrieval does not. If so, then finding a brain area that is activated during episodic retrieval but not semantic retrieval need not correspond to finding a database; it might reflect instead the brain areas involved in M-representation. It might also reflect the brain areas involved with the self-as-agent concept, or for temporality, and so on. This is not cause for despair. But it does mean that neuroimaging studies will have to be designed with careful attention to models of the computational machinery and the databases this machinery accesses in producing the familiar sense of a self with a personal past.

## CONCLUDING THOUGHTS

We began this paper by suggesting that an epistemological analysis might be more tractable, as well as analytically prior to, an analysis of what self/memory *is*. By taking this approach, we believe we not only have arrived at a clearer understanding of first-person epistemology, but have begun to make modest progress on the weighty problem of the ontology of autobiographical first-person experience.

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