SELF-KNOWLEDGE AND SELF-REFERENTIAL PROCESSING IN MEMORY DISORDERS: IMPLICATIONS FOR NEUROPSYCHOLOGICAL REHABILITATION

by

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DEDICATION

To my husband, Andrés, and my mother, Silvia.

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ABSTRACT

Damage to the brain can affect the core of the individual, i.e. the self. Results from a small number of studies with amnesic individuals indicate that patients' ability to show preserved knowledge of self may vary. The present study explored self-knowledge in patients with memory impairment as a result of confabulation, mild cognitive impairment, Alzheimer's disease and acquired brain damage. We found that different memory disorders differentially affected patients' self-knowledge. At least some patients showed a preserved sense of self, and were able to acquire information about another person that they had met postmorbidly. Frontal function and stability of cognitive impairments over time appear to be two variables important in determining whether patients can have a consistent and updated sense of self. We also explored the extent to which self-referential and other-referential processing might enhance memory in individuals with memory-impairment. The self-reference effect (SRE) and other-reference effect (ORE) have been consistently found in normal adults. Results indicated that patients showed a normal SRE and ORE. The SRE and ORE appeared to be at least partly dependent on degree of knowledge of the person being referenced, and were also related to general memory and frontal function. Only the SRE, however, was also related to patients' ability to improve memory as a result of emotional processing. These findings may have important implications for caregivers and healthcare professionals working with memory-impaired patients, and may pave the way to novel memory rehabilitation methods.

INTRODUCTION

Individuals who suffer memory loss as a result of neurological damage are often described as "no longer being themselves." Although damage to the medial temporal lobe (MTL) region of the brain is usually responsible for deficits in episodic memory, in many memory disorders other brain regions are affected as well, resulting in additional cognitive and emotional changes. These functional changes and the commonly accompanying lifestyle and role changes, might affect an individual's sense of self. Additionally, damage to certain brain regions, such as the prefrontal cortex (PFC) has been related to changes in personality (Miller, Seeley, Mychack, Rosen, Mena, & Boone, 2001). Relatively little is known, however, about whether individuals who become impaired in their ability to incorporate and integrate new life experiences into their existing knowledge structure know who they are, and whether the subgroup of individuals who also experience a change in their sense of self are able to get to know the person they have become. A small number of case studies have suggested that at least some amnesic patients do know who they are, i.e. they have a stable and updated sense of self (Klein, Chan, & Loftus, 1999; Klein, Loftus, & Kihlstrom, 1996; Klein, Rozendal, & Cosmides, 2002; Tulving, 1993). However, a single case study reported in the literature suggested that although individuals with Alzheimer's disease (AD) might have a stable sense of sense, their self-knowledge may be of their personality before the onset of AD (Klein, Cosmides, & Costabile, 2003). We conducted a study exploring the sense of self in a group of memory-impaired individuals (Marquine & Glisky, 2005), and found varying degrees of self-knowledge. These results indicate that different memory disorders might affect an individual's sense of self in varied ways, and that self-knowledge might be spared in at least some memory-impaired individuals. Understanding how a sense of self is affected by memory disorders could have important implications for health care professionals working with these patients and family members caring for them. The present series of studies explored the sense of self of a patient exhibiting a confabulatory syndrome (Study 1), a group of patients with AD and Mild Cognitive Impairment (MCI; Study 2) and a group of individuals with memory-impairment as a result of traumatic brain injury (TBI) and other forms of acquired brain damage (Study 3).

A related question is whether individuals with memory impairment can enhance their memory as a result of self-referential (SR) processing, i.e show a self-reference effect (SRE) in memory. Episodic memory disorders have been very resistant to rehabilitation. Nonetheless, it has been argued that adopting an integrated approach to rehabilitation, taking into account the types of memory that are impaired and spared, as well as the memory processes that are compromised and those that are preserved might prove to be crucial in the development of new interventions (Glisky & Glisky, 2002). Memory benefits from SR processing have been consistently found in healthy individuals (for a review see Symons & Johnson, 1997). Although no studies have been published exploring whether individuals with memory impairments can improve memory performance after SR processing, a previous study in our laboratory indicated that this might be the case. Study 3 attempted to replicate and extend these findings, and investigated whether individuals with memory impairment as a result of acquired brain damage can show memory improvement as a result of referring information to another they know well, i.e. show an other-reference effect (ORE). Additionally we were interested in exploring some of the potential mechanisms underlying the improvement seen in memory after SR processing, including emotional and cognitive explanations of the SRE.

BACKGROUND

I. Memory Disorders

Traditionally, the term amnesia has been used to define a condition characterized by a profound isolated memory disorder, in the presence of spared other cognitive abilities, such as attention, language, visuospatial abilities, and executive function. The hallmark characteristic of the classic amnesic syndrome is a significant defect in learning new explicit information (anterograde amnesia), although many people with amnesia also have difficulty remembering events occurring some time before the onset of the amnesia (retrograde amnesia; O'Connor & Lafleche, 2006).

This "pure" amnesic syndrome was first described in patients with damage to the hippocampus and other MTL structures. However, further research has identified a number of other brain regions involved in memory, including the PFC, diencephalon, and basal forebrain (for a review see Tranel & Damasio, 2002). The pattern of memory deficits observed in patients with brain damage varies, depending on which of these areas is affected and the extent of the lesion.

Patients with damage to the PFC usually exhibit memory deficits in difficult tasks, such as source memory, or tasks requiring strategic processes. Damage to the PFC usually results in working memory and executive function deficits. Executive deficits encompass a lack of strategic organization, perseveration, deficits in problem solving and planning, as well as disorders of initiation and goal-directed activities. The presence of these types of deficits may negatively impact an individual's ability to learn and retrieve information (Glisky, 2004). The diencephalic structures that have been implicated in memory include the dorsomedial and anterior nuclei of the thalamus, the mammillary bodies and the mammilothalamic tract. Severe anterograde amnesia and retrograde memory loss of variable duration is usually observed in patients with damage to these regions. Damage to basal forebrain regions also results in memory impairments, likely due to the cholinergic functions of the basal forebrain or to a disconnection of neocortical regions from the MTLs (Glisky, 2004).

Neurological conditions that give rise to memory impairments include traumatic brain injury, tumors, epilepsy, herpes simplex encephalitis, anoxia, cerebral vascular accidents, anterior communicating artery aneurysms, surgical ablation, Korsakoff's syndrome, and AD and other dementias (for a review see O'Connor & Verfaellie, 2002). Some of these conditions, such as rupture of anterior communicating artery aneurysms, traumatic brain injury and anoxia, result in impairments in memory that present acutely and that after approximately one year post insult remain relatively stable. However, other patients present initially with a relatively isolated memory problem that gets worse over time and progresses to include deficits in multiple cognitive domains (i.e. AD). Studies 1 and 3 included patients presenting with stable memory impairment, while Study 2 is concerned with patients suffering from conditions that have been associated with progressive memory decline.

II. Trait Self-Knowledge in Memory Disorders

The notion of self has represented a problem for philosophers for many centuries. Efforts to try to capture its essence date back to ancient history, and it is often difficult to operationalize the concept of self for scientific study. Self-knowledge has been defined as the ability to differentiate oneself from others and be aware of attributes and preferences related to oneself, including knowledge of one's personality traits (Amodio & Frith, 2006). The present work concerns a specific type of self-knowledge, i.e. knowledge of one's personality traits.

Knowledge of one's own personality traits has been purported to be represented in memory primarily in abstract, summary form, and be dependent on a semantic memory system (Klein & Loftus, 1993; Tulving, 1993). Moreover, it has been hypothesized that memory for specific behavioral exemplars of those traits may be represented independently from trait self-knowledge. If this was the case, knowledge of one's own personality traits (based on a semantic memory system) may be spared in instances where acquisition of new autobiographical information (based on an episodic memory system) is impaired. A few case studies have explored this hypothesis (Klein, Chan, & Loftus, 1999; Klein, Cosmides, & Costabile, 2003; Klein, Loftus, & Kihlstrom, 1996; Klein, Rozendal, & Cosmides, 2002; Tulving, 1993). These studies have asked memory-impaired patients to rate themselves on a list of personality traits on two occasions spaced in time, and have asked an informant (relative, significant other or caregiver) to rate the patient on the same list of traits. Two measures of self-knowledge are usually computed: "consistency" (also called "reliability" or "stability") of self-knowledge, is the relation between the two self-ratings by the patient, and "accuracy" (or "validity") of self-knowledge is the relation between the self-rating of the patient and the ratings by the informant of the patient. In the present series of studies we will use this same terminology, while acknowledging that the latter measure represents the correspondence or congruence between the ratings of a patient and his or her informant, not accuracy per se.

Tulving (1993) carried out the first study of this kind with patient K.C. This individual was a 40-year-old man, who had sustained a severe head injury at age 30 years due to a motorcycle accident. Following this accident, K.C.'s personality changed, as reported by his family, from being extraverted to being introverted. Additionally, he was left with no autobiographical memory for events before or after the accident. His semantic memory for facts acquired premorbidly was generally intact. He was able to acquire new semantic information postmorbidly, but his learning was impoverished. When asked to rate himself on a list of personality traits, K.C. did so consistently over time, and accurately as compared to his mother's rating of him. His ratings of his mother's personality were also congruent with his mother's own personality ratings. These results suggest that K.C. had updated his self-representation despite his lack of episodic memory for any personal events since his accident, and that he also had an accurate representation of another person who he had known since before the accident.

Klein, Rozendal, and Cosmides (2002) presented the case of patient D.B. He was a 78-year-old man, who had suffered hypoxic brain damage following a heart attack within two years of experimental testing. D.B. showed a profound amnesia for events in his life, and severe anterograde memory deficits upon formal testing. His personal semantic memory (i.e. memory for facts in his life) was partially intact. D.B.'s self-ratings were consistent over time and congruent with his daughter's rating of him. In contrast, his ratings of his daughter were more inconsistent over time than those of controls, and did not correspond to his daughter's ratings of herself. Klein and colleagues (2002) report that a CT scan of D.B.'s brain taken shortly after the hypoxic event occurred, showed "no sign of acute intracranial abnormality" (p. 114), and that a scan taken four months later revealed that "the ventricles and sulci appeared mildly prominent" (p. 114).

In another study (Klein, Loftus, et al., 1996) patient W.J., who had temporary retrograde amnesia as a result of a concussion and was unable to recall any events in her personal past from the last 6-7 months (a period of time covering her first quarter at college), was able to make reliable ratings of her personality characteristics as a college student while she was amnesic. Further, results from a case study of a 21-year-old autistic patient, R.J (Klein, Chan, & Loftus, 1999) indicated that he was able to rate himself accurately, in spite of a very limited memory for personal episodes.

Only one case study has been reported looking at trait self-knowledge in a patient with AD (Klein, Cosmides, & Costabile, 2003). Patient K.R., a 76-year-old woman, who had severe dementia as a result of AD (MMSE = 9/30), showed intact consistency of self-knowledge, while exhibiting profound episodic memory deficits. K.R.'s ratings of her own personality did not correspond to her daughter's ratings of K.R. at the present time, but matched her daughter's ratings of K.R. premorbidly. Additionally, K.R. was able to rate her daughter's personality accurately, but could not consistently or accurately rate her caregiver. Thus, K.R. did not show updated self-knowledge. Instead her knowledge seems to be of her personality before the onset of AD. Further, she had adequate knowledge of someone she knew premorbidly, but seemed to be unable to acquire personality knowledge of another person she had met postmorbidly.

There has been one case study reported in the literature exploring personality knowledge in confabulation (Conway and Tacchi, 1996). O.P. was a 73-year-old woman, who suffered a closed head injury resulting in bilateral damage to temporal and frontal lobe structures, and a persistent confabulatory syndrome. Her cognition and personality was formally assessed 12 to 18 months post-injury. She exhibited pronounced memory and executive functioning impairment, as well as deficits in the retrieval of personal semantic and autobiographical information as assessed by the Autobiographical Memory Interview (Kopelman et al., 1990). Changes in her personality were noted by close family members and explored using Catell's 16PF (Catell, 1986). Two of her sisters were asked to complete this instrument as O.P. would have done it pre- and post-morbidly. O.P. was unable to rate herself premorbidly, but completed the test as she felt herself to be post-morbidly. Although the authors did not report statistical analyses assessing O.P.'s personality, they report that her sisters' ratings indicated O.P.'s personality had changed. Moreover, O.P.'s personality profile was similar to her premorbid personality, as reported by her sisters.

In a previous study in our laboratory (Marquine & Glisky, 2005) we evaluated self-knowledge in a mixed group of patients with stable memory impairment, using a personality trait questionnaire. Patients exhibited varying degrees of consistency and accuracy of self-knowledge. Some members of our sample showed a stable and updated sense of self, while others did not. Preserved self-knowledge appeared to be related to frontal function. Better frontal/executive functioning was related to a more stable (r = .54) and accurate (r = .57) sense of self. Further, time since injury was another variable that seemed important in determining whether patients had a preserved sense of self. Although the correlation between time since injury and consistency of self-knowledge did not reach significance, there seemed to be a trend for longer period of time since injury to be related to more consistent self-knowledge (r = .48).

To sum up, these findings suggest that knowledge of one's personality traits may be resilient in the face of amnesia, despite profound deficits in autobiographical knowledge. However, not all memory-impaired patients have a consistent and valid sense of self. Damage to frontal lobe areas of the brain, stability of cognitive impairments over time and time since onset of symptoms may be important factors determining whether this is the case.

III. The Self-Reference Effect in Memory

Rogers, Kuiper and Kirker (1977) conducted the first study exploring the effects of self-referential processing as an encoding mechanism. In an incidental learning paradigm, participants judged trait adjectives under four orienting tasks: structural ("Printed in capital letters?), phonemic ("Rhymes with XXX?), semantic ("Means the same as XXX?) and SR ("Describes you?). Rogers and colleagues (1977) found the standard levels of processing effect (LOP; Craik and Lockhart, 1972; Craik and Tulving, 1975), i.e. recall on the semantic task was better than recall on the phonemic task, which was in turn better than recall on the structural task. In addition, the SR task demonstrated recall superiority to all other tasks. This improvement in memory as a result of SR processing compared to semantic processing came to be known as the SRE.

A number of studies exploring the SRE followed (for a review see Symons & Johnson, 1997), and have demonstrated that the SRE can be obtained with different SR encoding tasks, including self-descriptiveness (e.g. Klein, Loftus, & Burton, 1989; Rogers et al., 1977), autobiographical retrieval (e.g. Klein & Kihlstrom, 1986; Klein & Loftus, 1988; Klein et al., 1989) and imagery (Foley, Belch, Mann, & McLean, 1999). It has also been found that different types of materials including traits (e.g. Klein et al., 1989; Rogers et al., 1977) nouns (e.g. Klein & Kihlstrom, 1986; Klein & Loftus, 1988), and verb-noun phrases (Miall, 1986) can produce a SRE.

Researchers have also used other-reference (OR) comparison tasks, and found that comparisons that involve person reference (i.e. SR versus OR) have smaller SREs relative to SR versus semantic encoding comparisons. Moreover, the memory advantage from SR processing over OR is greatly reduced, and in some instances eliminated when a highly intimate other is rated in the comparison task. A meta-analysis by Symons and Johnson (1997) found that intimacy but not familiarity with the target other predicted the magnitude of the SRE, and concluded that reference to highly intimate others results in memory improvement almost as large as in SR processing.

Much research has been conducted with the purpose of explaining the mechanisms underlying the SRE. However, to date there has been no general agreement concerning this issue. Rogers and colleagues (1977), although situating the self at the deepest level of the LOP model, explained the SRE by virtue of a unique mnemonic aspect of the self. They proposed that the self functions as a "superordinate schema", which facilitates the processing of self-related information. The memory improvement for SR processing was not just attributable to deeper semantic processing, but instead reflected access to a qualitatively different, well-developed structure: the self schema.

The uncovering of conditions under which the SRE is largely reduced or eliminated have led some to suggest that the SRE can be explained without attributing any special mnemonic properties to the self, but rather as a consequence of ordinary memory principles. The greater elaboration and organization that occurs in SR processing (e.g. Keenan, Golding, and Brown, 1992; Klein & Loftus, 1988; Klein & Kihlstrom, 1986) as compared to other types of processing has been hypothesized to be responsible for the SRE. According to this view, processing that is elaborate and organizational, such as processing information in relation to a well-known other, would result in equally improved memory. A related view indicates that the significant element is the existence of a well-differentiated knowledge structure (e.g. Bower & Gillian, 1979). Another explanation concerns the affective aspect of SR processing (Keenan and Baillet, 1980). From this standpoint, the essential dimension that provides the basis for SR processing to improve memory is not the amount of knowledge employed in encoding the item, but the person's feelings about what he or she knows. According to this view, personal relevance, and the accompanying emotion associated with it could thus be an important factor related to improved memory performance after SR processing.

Despite the large number of behavioral studies on the SRE, to our knowledge, no studies have been reported exploring these effects in patients with memory impairment.

In the study in our laboratory (Marquine & Glisky, 2005) where we explored self-knowledge in a group of memory-impaired patients, we also tested these patients on a SRE paradigm. Participants studied 72 trait adjectives blocked by orienting task: structural ("Is this word typed in upper case letters?"); semantic ("Is the dictionary definition of this word positive?"); and SR ("Does this word describe you?"). Controls studied one single list followed by an immediate yes-no recognition test, while patients studied three separate lists, with each list followed by an immediate yes-no recognition test. We found both a LOP effect and a SRE in our group of individuals with memory deficits, and for most patients, the SRE was larger. However, there was variability within our sample, and benefits from SR processing in memory appeared to be at least partly dependent on frontal function ($r = .52$). The correlation between the SRE and consistency and validity of self-knowledge, however, did not reach significance, $r = .33$ and $r = .26$, respectively.

IV. Neuroimaging Studies and Self-Referential Processing

In the last few years there has been a growing body of literature exploring the neural correlates of SR processing. Results from a recent meta-analysis of imaging studies on SR processing (Northoff, Heinzel, de Greck, Bermpohl, Dobrowolny, & Panksepp, 2006) indicated that this type of processing might be mediated by cortical midline structures (CMS). The regions referred to as CMS by Northoff and colleagues (2006) include medial orbital prefrontal cortex (MOPFC; BA 11, 12), ventromedial prefrontal cortex (VMPFC; BA 10, 11), dorsomedial prefrontal cortex (DMPFC; BA 9), pre-and subgenual anterior cingulate cortex (PACC; BA 24, 25, 32), supragenual anterior cingulate cortex (SACC; BA 24, 32), posterior cingulate cortex (PCC; BA 23), retrosplenial cortex (RSC; BA 26, 29, 30), and medial parietal cortex (MPC; BA 7, 31). Cluster and factor analyses across all activations in CMS revealed three different regional clusters within the CMS: ventral, dorsal and posterior (Northoff et al., 2006). The ventral part includes the MOPFC, VMPFC and PACC; the dorsal part includes the DMPFC, and the SACC; and the posterior part includes the PCC, RSC, and MPC. The authors hypothesize that the ventral part is implicated in linking both extero- or interoceptive stimuli with respect to their self-relatedness, the dorsal part is implicated in the reappraisal and evaluation of self-related stimuli, and the posterior part in placing SR stimuli within a temporal context by relating it with past SR stimuli.

While Northoff and colleagues (2006) propose specific neural circuitry associated with the processing of self-relevant information, others have suggested that these brain circuits may support something broader than self processing, for example, person processing or processing of emotional information (for review, see Gillihan & Farah, 2005). In their review of the literature, Gillihan and Farah (2005) conclude that SR processing is mediated by the same neural systems involved in person-related processing in general, with the self merely being the person we know best and we care most about.

A. Personality Traits Rating

Self-knowledge, as investigated in the present study, refers to knowledge about one's own personality traits. A number of neuroimaging studies indicate a salient role of the medial prefrontal cortex (MPFC) in mediating the judgment of whether a series of traits apply to the self (Craik et al. 1999; Heatherton, Wyland, Macrae, Demos, Denny, &

Kelley, 2006; Johnson et al., 2002; Kelley et al., 2002; Ochsner, et al., 2005; Schmitz, Kawahara-Baccus & Johnson, 2004). Some of these studies have directly compared rating oneself to rating another person in a list of personality traits (Craik et al., 1999; Heatherton et al., 2006; Kelley et al., 2002; Ochsner et al., 2005; Schmitz et al., 2004). Results from these studies are equivocal and are reviewed in what follows.

In a positron emission tomography (PET) study (Craik, et al., 1999) participants' brains were scanned while they rated on a 4-point scale a series of traits presented visually. For each word participants engaged in one of four different tasks: they rated themselves (self condition), rated the Prime Minister of Canada (other condition), judged its social desirability (general or semantic condition), or judged the number of syllables contained in the word (structural condition). Next, participants' memory for the trait words was examined outside the scanner using a recognition test. Behavioral data showed a levels of processing, ORE and a SRE effect in memory. Statistical parametric mapping of the PET data indicated that self-, other- and desirability-ratings activated similar areas in the brain, i.e. they were associated with increased left hemisphere activation, predominantly left prefrontal activation, as compared to structural encoding. The authors argued that this common activation suggests that judgments related to the self may involve a generalized concept of the self or semantic self, and may not be substantially different from other semantic judgments. Additionally, the self condition resulted in more activation of the right anterior cingulate compared to the semantic condition, but no significant differences in activation were found between the self and other condition. However, partial least squares analyses on the PET data restricted to areas in the frontal lobes showed increased medial and right-sided prefrontal activations in the self condition compared to the other three conditions together. More specifically, the areas of increased activation included the medial frontal lobes, with a maximum activation slightly left of the midline (BA 10), but which extended more to the right (BA9); right middle frontal gyrus (BA 10) and right inferior frontal gyrus (BA 45).

Kelley and colleagues (2002) devised a similar paradigm using blocked-design functional magnetic resonance imaging (fMRI). Participants were imaged while making three different types of judgments about trait adjectives: self ("Does the adjective describe you?"), other ("Does the adjective describe U.S. president Bush?"), and case (Is the adjective presented in upper case letters?"). Stimuli were visually presented. Once outside of the scanner participants were given a recognition memory test for the words. Behavioral results found the typical LOP and SRE in memory. Blood oxygen level-dependent contrast fMRI data comparing both the self and other conditions with the case condition showed greater activity in the left inferior frontal cortex and the anterior cingulate. When self-judgments were compared with other judgments, greater activation was observed in MPFC and the posterior cingulate. However, the greater activations in the posterior cingulate were observed in both the SR and case condition as compared to the OR condition. The authors argued that the added selective activation of MPFC regions is suggestive of a unique aspect of the self.

In another blocked-design fMRI study, Schmitz and colleagues (2004) imaged participants while they rated personality traits under three tasks: self, close other (close friend or relative) and semantic (determine valence of word). Self and other evoked similar activations in anterior MPFC and retrosplenial cortex. The direct comparison between self- and other-reference resulted in greater right-sided activations in dorsolateral PFC for the SR processing, while the MPFC was not differentially active for self or other judgments.

Ochsner and colleagues. (2005; Experiment 1) used a blocked fMRI design and imaged participants making 4 types of judgments regarding trait adjectives: self, close other (friend), semantic (determine whether word described trait that most people would consider a positive personality characteristic), and structural (determine whether word contained 2 syllables). Results indicated that in comparison to a structural condition, the self condition recruited dorsal MPFC/paracingulate cortex. Additionally, the close other > structural contrast revealed activation of MPFC that overlapped and extended more rostrally then the activation self > structural. However, there were no significant differences between self and close other, or between self and semantic conditions. In Experiment 2 (Ochsner et al, 2005) participants were imaged while making the following types of judgments: self (describes you), close other (describes friend and/or relationship partner), non-close other (describes previous teacher assistant), and structural (determine whether word contained more curved or straight lines). Additionally, participants rated the extent to which the close other and the non-close other would judge items as describing the participant. Self, close other and non-close other conditions in comparison to a structural condition resulted in similar patterns of activation including regions of MPFC, anterior cingulate, posterior cingulate and precuneus, inferior parietal and the middle and inferior temporal gyry and temporal pole. Self > close other, and self > non-close other contrasts both activated right lateral PFC, with the latter also activating dorsal MPFC, anterior cingulate, and superior parietal cortex.

Heatherton and colleagues (2006) used an event-related fMRI study to examine whether MPFC differentiated self from close other referential processing. Participants were imaged making three types of judgments about trait adjectives: self, other (best friend), and structural (determine whether word was printed in uppercase letters). Once outside the scanner, participants' memory for the traits was assessed. Analysis of behavioral data showed a SRE, and ORE, and differences between self and other did not reach significance. Analysis of fMRI data were performed in an a-priori defined region of interest in the MPFC based on Kelley and colleagues' (2002) findings. Results showed increased activity in this region for self compared to a close other condition, and self compared to a structural condition.

Findings from behavioral studies on the SRE highlight the importance of the level of intimacy with the other person being rated. Along with these findings, in a recent review of the neuroimaging literature, Amodio and Frith (2006) suggested that an important distinction among studies, which might explain the differences in findings, represents whether the other person being rated is a close other (e.g. friend, or relative) or whether it is a non-close other (e.g. the president). However, even when we distinguish between close and non-close others, a clear pattern of findings does not emerge.

Overall, it does appear to be the case that SR processing can at least in some cases result in increased activity in certain brain regions when compared to OR processing; and when it does either the MPFC or right PFC are involved. However, the regions that have most often been associated with SR processing, are often also activated in OR processing and in the processing of emotion (Amodio & Frith, 2006; Gillihan & Farrah, 2005). Thus, imaging studies have not provided solid evidence concerning the special status of the self (see Gillihan & Farah, 2005).

B. SR Processing and Memory

Although a large number of neuroimaging studies have investigated SR processing, only a small number of them have explored the effect of SR processing in memory (Macrae et al., 2004; Fossati et al., 2003, 2004; Lou et al., 2004). In Macrae and colleagues' study (2004) participants judged whether a series of trait adjectives described them. They grouped items in two ways: remembered versus forgotten and self-descriptive vs. non self-descriptive. Both remembered (vs. forgotten) items and self-descriptive (vs. non self-descriptive) items revealed activation in MPFC at encoding. Fossati and colleagues imaged participants while encoding (Fossati et al., 2003) and retrieving (Fossati et al., 2004) trait adjectives under a SRE paradigm. Both encoding and correct retrieval of items under SR condition engaged the DMPFC. In another study (Lou et al., 2004) retrieval of items studied under SR condition engaged the DMPFC, the PCC, and left VLPFC. To sum up, similar brain areas in the MPFC are recruited both when making self-knowledge judgments during encoding and when retrieving information learned in this manner. It has been argued that these results indicate that a common process, i.e., SR processing is operating both at encoding and retrieval (Fossati et al., 2004).

STUDY 1: CASE STUDY ON CONFABULATION

I. Background: Confabulation

Confabulation has been defined as "honest lying" and its trademark characteristic is memory distortion in the context of a genuine belief in the produced false information (Gilboa & Moscovitch, 2002). Maybe because of the heterogeneity of presentation within patients, there is not a universally agreed on definition of confabulation at this time (Metcalf, Langdon, & Coltheart, 2007). Confabulations sometimes appear to be true memories misplaced in time and place, while others seem to lack any basis in reality (Gilboa & Moscovitch, 2002). People who confabulate appear to genuinely believe their false memory and sometimes act upon their confabulation reflecting this belief (Metcalf, et al., 2007). Confabulations are most prominent in episodic memory, but may also become present in personal and general semantic memory (Dalla Barba, 1993b; Fotopoulou, Solms, & Turnbull, 2004; Kopelman, Ng, & Van Den Brouke, 1997; Moscovitch & Melo, 1997). Moreover, confabulatory states typically change over time and most patients eventually stop confabulating (Schnider, Ptak, vonDaniken, & Remonda, 2000).

A. Neuropathology

Confabulatory states are most commonly seen in patients with Korsakoff's syndrome (Benson, et al., 1996; Berlyne, 1972; Mercer, Wapner, Gardner, & Benson, 1977; Kopelman, 1987; Kopelman et al., 1997) and patients who have survived ruptured aneurysms of the anterior communicating artery (ACoA; Baddeley & Wilson, 1988; Damasio, et al., 1985; DeLuca & Cicerone, 1991; DeLuca & Diamond, 1995; Fischer, Alexander, D'Esposito, & Otto, 1995; Moscovitch, 1989). They can also occur after traumatic brain injury (Baddeley & Wilson, 1988; Berlyne, 1972; Moscovitch & Melo, 1997), herpes simplex encephalitis (Moscovitch & Melo, 1997), rupture of the posterior communicating artery (PCoA; Dalla Barba et al, 1997a; Mercer, Wapner, Gardner, & Benson, 1977), as well as in relation to multiple sclerosis (Feinstein et al, 2000), fronto-temporal dementia (Nedjam et al., 2000; Moscovitch & Melo, 1997), and Alzheimer's Disease (Dalla Barba, Nedjam, & Dubois, 1999; Nedjam et al., 2000; Kopelman, 1987).

A recent review of 79 cases reported in the literature (Gilboa and Moscovitch, 2002) indicated that lesions to the ventromedial prefrontal cortex (VMPFC) are sufficient to produce confabulation, even when damage to other regions is minimal or absent. Other brain areas that were found to also be usually damaged in confabulating patients include the basal forebrain, anterior insula, capsular genu, amygdala, perirhinal cortex and hypothalamus. It is worth noting that structural brain damage cannot account completely for confabulation, since spontaneous confabulation often subsides within a few weeks or months. In a study of eight confabulators, seven stopped confabulating (Schnider, et al., 2000). Schnider and colleagues (2000) indicated that the duration of confabulations was dependent on site and extent of lesion. The one patient who showed persistent confabulation after more than five years had the most extensive damage, i.e. orbitofrontal cortex extending up to the anterior horn of the lateral ventricles (Schnider, et al., 2000). It has also been suggested that metabolic or other neurochemical changes (Kopelman, 1999) interacting with psychological processes that inhibit confabulation

(Gilboa and Moscovitch, 2002), could be underlying the fleeting nature of confabulations.

B. Theories of Confabulation

A number of theories have been proposed to account for confabulations. An early proposal considered confabulations a reflection of psychological defense mechanisms, the main purpose of which was to fill in memory gaps (e.g. Berlyne, 1972). This compensation theory has lost proponents as experimental data provided little evidence to support this view (e.g. Mercer, Wapner, Gardner, & Benson, 1977), and as it became apparent to clinicians and researchers that confabulating patients are typically unaware of their memory disorder. Moscovitch (1989) has suggested that although primary confabulations (i.e., the spontaneous or first elicited ones) are not motivated by concern on covering memory gaps, secondary confabulation (the ones produced to account for inconsistencies in primary confabulations) may. Others (e.g. Williams and Rupp, 1938) have suggested that increased suggestibility and a greater tendency to utilize external cues during memory retrieval could be psychological mechanisms underlying confabulations. However, this idea has also had little empirical support (Mercer et al. 1977).

The most widely accepted theories these days view confabulation as a *cognitive* disorder, i.e. a temporal (Dalla Barba 1993a, 1993b; Schnider, vonDaniken, & Gutbrod, 1996; Schnider, 2003), source monitoring (Johnson, Hashtroudi, & Lindsay, 1993; Johnson, O'Connor, & Cantor, 1997) , or strategic retrieval disorder (Gilboa and Moscovitch, 2002).

The temporal disorder hypothesis asserts that confabulating patients have an impaired sense of chronology (Dalla Barba 1993a, 1993b; Schnider et al. 1996; Schnider, 2003). They have difficulty remembering the order of occurrence of events, and hence may confuse aspects of an event with other events that occurred at another point in time. Schnider and colleagues (1996) maintain that confabulators may be distinguished from other types of amnesic patients by their tendency to use information that was relevant in a previous context and interject it in a current context when it is no longer relevant, i.e. temporal context confusion. Dalla Barba and colleagues (1997b, 1999; DallaBarba, 1993a, 1993b) are the other main proponents of confabulation as a temporal disorder. They posit the existence of two types of consciousness: a knowing and a temporal consciousness. Although confabulators are aware of a past, present and future, impairments in temporal consciousness result in deficits in searching in long-term memory. Hence, they tend to use the more stable elements from long-term memory such as habits and semantic knowledge, and apprehend them as personal events.

More generally, the source monitoring hypothesis states that confabulation results from an impairment in one's ability to determine the source of one's memories (Johnson et al, 1993, 1997), that is, the time or place where they occurred, or even whether they referred to internally or externally generated events (i.e. imagined events vs. "real" memories). Temporal and source monitoring theories have been criticized on the basis that deficits in temporal context and source monitoring are not unique to confabulators, but instead occur in other neurological populations as well (e.g. Schnider, vonDiken & Gutbrod, 1996b). Gilboa and Moscovitch (2002) emphasize that the more bizarre forms of confabulation cannot be explained by temporal-context confusion, and suggest that a disturbed sense of chronology is merely one of the symptoms of confabulation. It is worth noting that the main proponents of source monitoring theory (i.e. Johnson and colleagues) posit that this theory should not be viewed as an all encompassing explanation of confabulation, but may be complemented by other theories.

The strategic retrieval hypothesis (Moscovitch, 1989; Gilboa & Moscovitch, 2002; Gilboa et al., 2006) stems from the observation that confabulation affects remote memories acquired pre-morbidly, as much as post-insult memories. Hence, confabulation has been hypothesized to be a deficit in retrieval rather than in encoding of information. Gilboa and Moscovitch (2002) distinguish between associative and strategic retrieval. The former is cue-dependent, automatic and mediated primarily by the medial temporal lobes. In strategic retrieval the target memory is not elicited immediately by a given cue, but needs to be recovered through a strategic process. This strategic retrieval process includes: (a) framing the memory problem and initiating a search, (b) constraining it and guiding it, and (c) once a memory is retrieved, monitoring the recovered memory and determining whether it is consistent with the objective of the memory task and other knowledge (Gilboa et al, 2006). The main criticism against a strategic retrieval theory of confabulation has been that not all confabulators exhibit executive deficits (Dalla Barba et al., 1997b). In response to this objection, Moscovitch and Melo (1997) assert that traditional tests of executive function may not tap damage to medial portions of the frontal lobes.

More recently, motivational/emotional aspects of confabulation have been systematically studied in an effort to complement cognitive theories of confabulation. Fotopoulou and colleagues (Fotpoulou, Solms, & Turnbull, 2004) described the case of an individual, E.S., who exhibited a confabulatory syndrome following removal of a meningioma in the pituitary and suprasellar region. Findings from this case study indicated that E.S.'s confabulation tended to be of a positive nature. The authors argued that confabulation may have a motivational component, exemplified by a systematic positive bias of confabulations. In line with these findings, a review of 16 cases of confabulatory patients found that in all cases the confabulated patient's location was more pleasant than the actual one (Turnbull, Berry, & Evans, 2004). Results from another study (Fotopoulou, Conway & Soms, 2007) showed that a group of confabulating patients were (not surprisingly) more likely than amnesic non-confabulating patients to misrecognize past autobiographical and imagined events as currently relevant. Moreover, although both groups were more likely to incorrectly recognize more pleasant than unpleasant events, confabulating patients were more prone to do so. Fotopoulou and colleagues (2007) concluded that a more adequate account of confabulation should take into account both cognitive dysfunctions and emotional influences in the production of confabulations.

Metcalf and colleagues (Metcalf, Langdon, & Colheart, 2007) attempted to propose such an account through their three-factor cognitive-neuropsychological model of confabulation. They argued that executive retrieval control (first factor) and evaluation (third factor) deficits may explain why confabulations occur in most cases.

Additionally, the content of confabulations is likely to be influenced by the person's personal biases (emotional/motivational) and information available in the autobiographical memory store (second factor). As exemplified in the interpretation of two cases described by Metcalf and colleagues (2007), the patient's concept of self is at least one of the potential personal biases in this model.

Similarly, earlier models of confabulation (Kopelman, 1999) and of autobiographical memory (Conway & Tacchi, 1996) also argued for a role of the self in confabulated memories. Kopelman's model of false memories/confabulation (Kopelman, 1999) is comprised of a medial temporal/diencephalic memory system, which plays a critical role in encoding and consolidation and has direct connections with an autobiographical/episodic memory system and a frontal control/executive system. He asserts that spontaneous confabulations are likely the result of deficits within the frontal/executive system. His model also postulates a "self" system (i.e. personal semantic belief system) that has strong connections with the frontal/executive and autobiographical memory system, and as such may influence the process of retrieval and memory verification.

Conway describes autobiographical memory as effortfully constructed and maintained (Conway & Tacchi, 1996). He posits that knowledge is represented in a 3-tier hierarchy which includes: abstract/generic conceptual knowledge, general event knowledge, and sensory-perceptual, event-specific, episodic memories. Knowledge at different levels of abstraction is used to index knowledge at other levels. Once knowledge is activated it is then evaluated by control processes. These control processes, which are mediated by frontal structures place constraints on what mental states are accepted as memories. One important source of constraint, according to Conway, is the self. The plans and goals of the current self influence encoding and retrieval processes, by determining what is retained and evaluating activated knowledge for self-relevance and self-consistency. In his description of a confabulatory patient, O.P., Conway states that impairments in the evaluation of output from long term memory are probably critical in explaining persistent confabulations.

II. Purpose and Hypothesis

The main purpose of the present case study was to explore the sense of self in a case of profound memory distortion, i.e. confabulation. Most case studies reported in the literature argue that self-knowledge may be spared in individuals with memory loss. However, one case study with an AD patient indicated that although a sense of self may be preserved in AD, it may be from a past self. Results from our previous study with memory-impaired patients indicated that maintaining a consistent and updated self-representation was related to frontal function. Our findings along with the results from neuroimaging studies that have demonstrated MPFC involvement in SR processing, suggest that patients with damage specifically to MPFC might show difficulties in maintaining a self-representation. A descriptive study in a patient with a confabulatory syndrome, which is known to compromise VMPFC, suggested this may be the case (Conway & Tacchi, 1996).

We predicted that patients who exhibit confabulations would experience a breakdown in their sense of self. More specifically, we hypothesized that confabulatory patients' self personality-rating would be inaccurate and thus not congruent with ratings made by another person. As far as the consistency of self-rating is concerned, we hypothesized that this might change from one patient to the next. Patients that repetitively report the same confabulations, may have a consistent sense of self, and thus would rate themselves in a consistent way. On the other hand, the confabulatory account need not be coherent. Hence, if the account is not internally consistent it is also likely to be inconsistent over time.

III. Methods

A. Participants

Confabulatory Patient and his Informant. J.S. was a 74-year-old right handed man, who had completed 14 years of formal education. He developed severe memory impairment and a persistent confabulatory syndrome following rupture of an anterior communicating artery aneurysm in 1995 (Rapcsak, Kaszniak, Reminger, Glisky, Glisky, & Comer, 1998; Rapcsak, Reminger, Glisky, Kaszniak, & Comer, 1999). His profound amnesia and spontaneous confabulations were still present at the time he participated in the present study. All testing sessions were conducted at the nursing home where J.S. was living.

J.S. exhibited a vast amount of confabulations, both spontaneous and provoked, which included both plausible information and bizarre or implausible accounts. Some of his confabulations focused on particular themes and repeated themselves during different testing sessions. For example, by the end of the sessions he would ask experimenters to check with his secretary (a female nurse) whether he was going to be available for testing the following week since he had a trip planned in the near future, usually either to Africa or South America. He would also frequently add that he had visited a few continents during the past few days. Another spontaneous confabulation that he repeated during different sessions was that his teeth had been knocked out while playing basketball with a little red-haired girl a few days prior. She had hit him with her elbow and knocked out all his front teeth. He also exhibited spontaneous confabulations that did not seem to repeat themselves during different sessions. For instance, he once said his grandmother had come to visit him the day before the evaluation. Another time he said he had been to the university to give a talk about medical devices the week before. Unfortunately, J.S. had lost all contact with his family and hence it was impossible to determine whether his confabulations could be traced back to elements of actual events in his past.

Table 1a shows J.S.'s neuropsychological test performance. J.S. was very pleasant and cooperative throughout the course of the assessment, despite his profound memory difficulties, confabulation and impulsivity. His performance on a test of premorbid intellectual function (North American Adult Reading Test, NAART, Spreen & Strauss, 1998) was average (NAART Full Scale IQ [FSIQ] = 105). His current intellectual function, as measured by the Wechsler Abbreviated Scale of Intelligence (WASI, Wechsler, 1999) was lower than expected (WASI FSIQ = 85) given his estimated premorbid abilities.

J.S. showed no difficulties on tests of confrontational naming (Boston Naming Test, BNT) and category fluency (Animal Naming). His performance on tests of memory (i.e. Wechsler Memory Scale-Third Edition [WMS-III; Wechsler, 1997], the California

Verbal Learning Test [CVLT; Delis, Kramer, Kaplan, & Ober, 1987], and the Visual Paired Associates subtest from the Wechsler Memory Scale-Revised [WMS-R; Wechsler, 1987) ranged from low average to severely impaired. His memory performance is best characterized by difficulty in acquiring both visual and verbal information. He also showed a striking tendency to endorse lure items as previously presented. For example, in the recognition portion of the CVLT he recognized 15 out of 16 target items, but he also made 16 out of 16 possible false alarms.

The following tests were administered to assess his executive function: the modified Wisconsin Card Sorting Test (WCST; Hart, Kwentus, Wade, & Taylor, 1988), a word fluency test, using initial letters F, A, and S (Spreen & Benton, 1977), Mental Arithmetic subtest from the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981), and Mental Control and Backward Digit Span from the WMS-III (Wechsler, 1997). J.S.'s performance on the WCST was dramatically impaired, mainly as a result of a vast number of perseverative incorrect responses in this task. He also exhibited difficulties on tasks of verbal fluency and manipulating things in mind.

Overall, J.S.'s cognitive function is best characterized by impairments in executive function, which are highlighted by difficulties in set shifting, problem solving, manipulating things in mind, acquiring and retrieving information and verbal fluency. This pattern of performance is generally seen in patients with frontal damage.

Table 1a. J.S.'s neuropsychological test performance

Function	Test	Performance	Interpretation
Intellectual Function			
"Premorbid"	**NAART[a] Full Scale IQ**	105	average
Current	**WASI[a]**		
	Verbal IQ	95	average
	Performance IQ	79	borderline
	Full scale IQ	85	low average
Language	**Animal Naming[b, c]**	16	average
	Boston Naming Test[b]	57/60	average
Memory	**WMS-III[a]**		
	Auditory Immediate	86	low average
	Visual Immediate	68	impaired
	Immediate Memory	73	borderline
	Auditory Delay	83	low average
	Visual Delay	88	low average
	Auditory Recognition Delay	65	impaired
	General Memory	77	borderline
	CVLT[b]		
	List A Trial 1	5/16	average
	List A Trial 5	6/16	borderline
	List A Short-Delay Free Recall	2/16	impaired
	List A Short-Delay Cued Recall	5/16	borderline
	List A Long-Delay Free Recall	1/16	impaired
	List A Long-Delay Cued Recall	3/16	impaired
	Recognition Measures		
	Recognition Hits	15/16	high average
	False Positives	16/16	impaired
	WMS-R[b]		
	Visual Paired Associates I	6/18	impaired
	Visual Paired Associates II	2/6	impaired
Executive	**WCST[b]**		
	Categories completed	0/6	impaired
	Correct Responses	0	--
	Errors	72/72	impaired
	Perseverative Errors	71	impaired
	Verbal Fluency[b,c]	20	borderline
	Mental Control[b]	11	borderline
	BDS[b] (longest span)	3	low average
	WAIS-R Arithmetic[b]	9	average

Note. BDS = Backwards Digit Span; CVLT = California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987); NAART = North American Adult Reading Test (Spreen & Strauss, 1998); WAIS-R = Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981); WASI = Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999); WCST = Wisconsin Card Sorting Test (Hart, Kwentus, Wade, & Taylor, 1988); WMS-R = Wechsler Memory Scale-Revised (Wechsler, 1987); WMS-III = Wechsler Memory Scale-Third Edition (Wechsler, 1997).
[a] Index scores; [b] Raw scores; [c] Norms from Tombaugh et al. (1999).

Figure 1a shows a CT scan of J.S.'s brain. Visual inspection of the scan indicates bilateral infarction of the basal forebrain/septal and the VMPFC region, including orbitofrontal cortex and anterior cingulate gyrus. The lesion was more extensive on the right side, where it extended into frontopolar and inferior dorsolateral prefrontal areas.

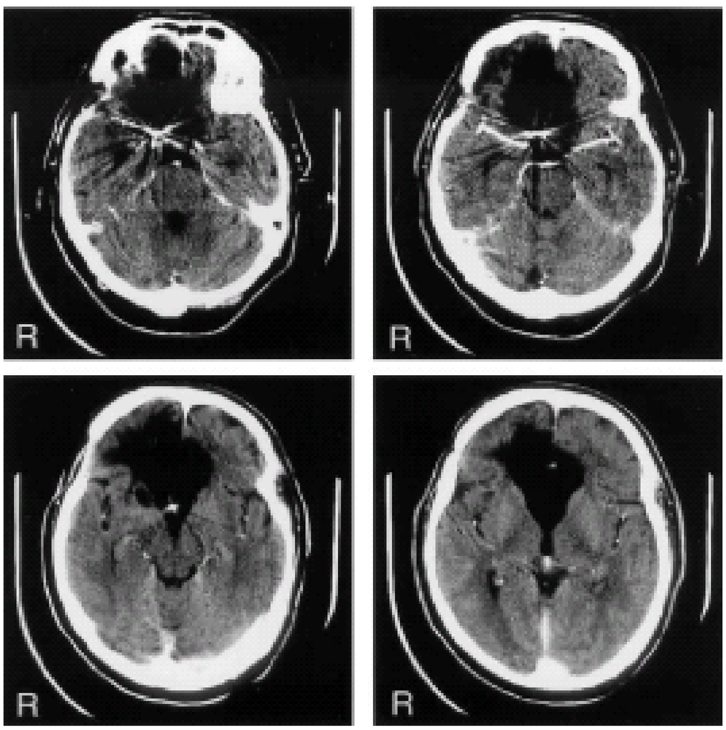


Figure 1a. CT scan of J.S.'s brain

A nurse who worked at the nursing home where J.S. had been living for 9 years, nurse P, served as his informant. Nurse P was a 47-year-old man, who had 14 years of education and had known J.S. for 5 years. We asked him to participate in the study after we learned that he was the caregiver whom J.S. had the most contact with. Nurse P reported knowing J.S. very well.

Memory-Impaired Control and his Informant. E.C. was a 75-year-old right-handed man, who completed 12 years of formal education. He developed a progressive memory impairment and was diagnosed with probable early stage AD according to the criteria set forth by the National Institute of Neurological and Communicative Diseases and Stroke and Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA; McKhann, Drachman, Folstein, Katzman, Price, & Stadlan, 1984). Diagnosis was made by a neurologist based on clinical examination and neuropsychological assessment results. At the time of E.C.'s participation in the current study he was still living on his own. However, his daughter reported that he had stopped doing volunteer work a few months before because of his cognitive difficulties, he had had difficulties managing his finances on his own, and had become lost in familiar places on a few occasions.

Table 1b shows E.C.'s neuropsychological test performance. E.C. was very pleasant and seemed to put forth a good effort throughout his participation in the study. Behaviorally, his memory difficulties were evident by his tendency to repeat himself during the evaluation. For example, he asked on various occasions about the purpose of the evaluation. Every time this was explained to him he appeared to understand the objective of the study without difficulty, and he would add that he hoped the results of the study would "help people like (him) that have memory problems". This statement also exemplifies E.C.'s awareness of his difficulties.

Table 1b. E.C.'s neuropsychological test performance

Function	Test	Performance	Interpretation
"Premorbid" IQ	**Barona Equation Full Scale IQ**[a]	109	average
Grl. Cognitive Function	**MMSE**[b]	20/30	impaired
Language	**Animal Naming**[b, c]	14	average
Memory	**WMS-III**[b]		
	Logical Memory 1st Recall	16/50	average
	Faces I	25/48	impaired
	Verbal Paired Associates I	1/32	impaired
	CVLT[b]		
	List A Trial 1	3/16	low average
	List A Trial 5	5/16	impaired
	List A Short-Delay Free Recall	4/16	low average
	List A Short-Delay Cued Recall	3/16	impaired
	List A Long-Delay Free Recall	1/16	impaired
	List A Long-Delay Cued Recall	3/16	impaired
	Recognition Measures		
	Recognition Hits	4/16	impaired
	False Positives	0/16	average
	WMS-R[b]		
	Visual Paired Associates I	8/18	impaired
	Visual Paired Associates II	2/6	impaired
Executive	**WCST modified**[b]		
	Categories completed	6/6	average
	Correct Responses	46	--
	Errors	24	average
	Perseverative Errors	5	average
	Verbal Fluency[b,c]	34	average
	Mental Control[b]	27	high average
	BDS[b] (longest span)	4	average
	WAIS-R Arithmetic[b]	14	high average

Note. BDS = Backwards Digit Span; CVLT = California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987); NAART = North American Adult Reading Test (Spreen & Strauss, 1998); WAIS-R = Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981); WASI = Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999); WCST = Wisconsin Card Sorting Test (Hart, Kwentus, Wade, & Taylor, 1988); WMS-R = Wechsler Memory Scale-Revised (Wechsler, 1987); WMS-III = Wechsler Memory Scale-Third Edition (Wechsler, 1997).

[a] Index scores; [b] Raw scores; [c] Norms from Tombaugh et al. (1999).

E.C.'s "premorbid" intellectual function is estimated to be in the average range, based on demographic characteristics (Barona Equation FSIQ = 109). On a measure of current general cognitive function his performance was mildly impaired (MMSE = 20/30). He was oriented to person and place, but not time. Although he correctly repeated 3 words immediately after presentation, he was unable to provide any of them after a delay. His performance on tests of category fluency and executive function was average to high average, and within expectation given his estimated premorbid function. Although his immediate memory performance was relatively well preserved, he showed a slow learning curve and impaired delayed memory performance. As shown in Table 2, E.C.'s demographics and degree of memory impairment were comparable to that of J.S., but E.C.'s frontal function was intact.

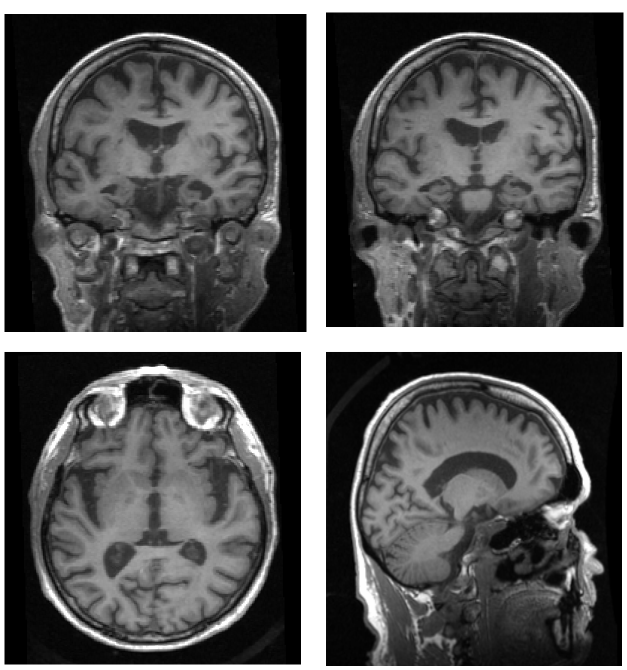


Figure 1b. MRI of E.C.'s brain

Figure 1b shows a structural MRI of E.C.'s brain. Visual inspection of the scan indicates overall volume loss, and pronounced atrophy of mediotemporal and parietal brain structures.

E.C.'s daughter, who was 45 years of age and had 12 years of education, served as his informant. She reported knowing her father very well. Although E.C. was living alone during the time he participated in the study, his daughter was involved in his care and visited with him at least once a week.

Normal Controls and their Informants. A group of nine healthy older adults (five males) matched in age and education to J.S. (see Table 2), and without a history of neurological or psychiatric illness served as controls. Controls were recruited from a pool of healthy, community-dwelling adults, who had undergone neuropsychological assessment at the Amnesia and Cognition Unit at the University of Arizona, within two years of experimental testing. Each individual in the pool had completed a battery of neuropsychological tests that have been identified as indicative of MTL function (i.e., memory factor) and frontal lobe function (i.e. frontal factor) in previous studies (Glisky et al., 1995, 2001).

The tests contributing to the memory factor included Logical Memory I first recall total score, Faces I and Verbal Paired Associates I total raw score from the WMS-III (Wechsler, 1997); Visual Paired Associates II total raw score from the WMS-R (Wechsler, 1987); and the total raw score of the Long-Delay Cued Recall measure from the CVLT (Delis, Kramer, Kaplan, & Ober, 1987). The tests contributing to the frontal factor included: number of categories achieved on the modified WCST (Hart, Kwentus, Wade, & Taylor, 1988), the total number of words generated in a word fluency test, using initial letters F, A, and S (Spreen & Benton, 1977), Mental Arithmetic from the WAIS-R (Wechsler, 1981), Mental Control from the WMS-III (Wechsler, 1997), and Backward Digit Span from the WMS-III (Wechsler, 1997).

Based on their neuropsychological testing performance individuals in the pool had been assigned two composite scores, one representing memory function, and the other frontal function. The composite scores for each individual represent average *z* scores for those tests loading on each factor, relative to a 227-member normative group. All controls selected had memory and frontal function scores which fell within one standard deviation from the mean.

Table 2. Descriptive Characteristics of J.S., E.C. and normal controls

Participants	Age	Education	Memory Function[a]	Frontal Function[a]
J.S.	74	14	-2.39	-2.03
E.C.	75	12	-2.48	0.47
Controls[b]	74.78 (6.04)	15.22 (3.03)	-0.08 (0.43)	0.11 (0.70)

Note. [a] *z* scores (see text); [b] *M* (*SD*).

A group of nine individuals who reported knowing controls very well (three friends, one child, and six spouses) without a history of dementia, stroke, alcohol abuse, or current psychiatric illness, served as informants of controls. Informants reported having known controls for a number of years, $M = 31.67$ ($SD = 19.57$).

B. Materials and Procedure

Participants were assessed individually. J.S. and E.C. completed the neuropsychological tests that were necessary to compute the memory and frontal factor scores. Similarly to controls, they were assigned two *z* scores (one representing memory function, and the other frontal function) based on their performance.

We used the personality trait questionnaire that we had used in our previous study with memory-impaired individuals (Marquine & Glisky, 2005) to test participants' self-knowledge. We added another version of this questionnaire (i.e. same traits in a different order) to test participants' other-person knowledge. The questionnaire consisted of 84 words selected from a pool of normalized personality trait adjectives (Anderson, 1968). Trait words were all moderately to highly meaningful. Meaningfulness ratings of the items ranged from 326 to 386 (M = 358). Half of the traits in the questionnaire were positive (e.g. considerate, trusting, intelligent) and half negative (e.g. moody, prejudiced, obstinate). In Anderson's (1968) list, words were ordered according to their likeability ratings. In the present study a word was considered positive if it was one of the first 252 words listed in the list and negative if it had a ranking between 253 and 555. The mean ranking for positive words was 97 and the mean ranking for negative words was 391.

Participants rated the extent to which each trait applied to them and their informant using a four-point scale with the following options: not at all, somewhat, quite a bit, and definitely. Instructions were typed at the top of each page and read as follows for self-ratings of J.S. and controls: "Please indicate to what extent each of the following traits applies to you, by circling the appropriate response for each trait". Instructions were appropriately modified for other-person ratings of J.S. and controls, and for informants.

J.S. and controls were asked to indicate how well each trait described them and their informant on two separate occasions, spaced a week to 10 days apart. The same adjectives, but in a different order, were presented on each occasion. Informants of patients and controls rated how well each trait described the patient (or control) at the present time, and rated how well each trait described themselves.

IV. Results

A. Valence of Self-Ratings

To assess the valence of self-ratings we calculated the proportion of positive and negative items that were endorsed by participants, i.e. received a rating of 3 ("quite a bit") or 4 ("definitely") in the personality trait questionnaire (see Table 3). A paired sample t-test performed on proportion of positive and negative items endorsed by controls, showed that controls rated significantly more positive items as self-referential both at timepoint 1 and 2, t (8) = -20.41 (p<.001), and t (8) = -13.23 (p<.001), respectively.

J.S.'s performance differed from that of controls only by the fact that he tended to endorse more negative items as self-descriptive than controls at timepoint 1 (i.e. his proportion of endorsed negative items fell more than 2 standard deviations below the mean of controls). However, he endorsed a comparable proportion of positive items to that of controls, both at timepoints 1 and 2. He also endorsed a comparable number of negative items at timepoint 2. E.C.'s performance fell well within the normal range.

Table 3. Proportion of items endorsed as self-descriptive by valence

	Timepoint 1		Timepoint 2	
Participants	Positive	Negative	Positive	Negative
J.S.	0.76	0.48	0.59	0.14
E.C.	0.98	0.05	0.98	0.10
Controls[a]	0.87 (0.13)	0.08 (0.05)	0.84 (0.18)	0.09 (0.05)

[a] *M* (*SD*)

B. Consistency and Accuracy of Self- and Other-Person Knowledge

We used intraclass correlation coefficients (ICCs; McGraw&Wong, 1996) for our analyses of the personality trait questionnaires' data because we were interested in examining the relationship among variables of a common class, i.e. variables that share both their metric and variance. Moreover, different types of ICCs allowed us to make within- and between-subjects comparisons. To explore the consistency of participants' self- knowledge, one-way ICCs, single measure (i.e. ICCs[1]) were calculated between the first and second ratings of participants' self-ratings in the personality trait questionnaire. To investigate the validity of the participants' self-knowledge, two-way mixed ICCs, absolute agreement (i.e. ICCs[A,1]) were conducted between the ratings of participants on the personality trait questionnaire on the first occasion and their informants' ratings of the participants on this questionnaire.

As shown in Table 4 results indicated that J.S.'s self-ratings were unreliable, *ICC(1)* = -.02, *p* = .58. Moreover, his self-ratings did not agree with the ratings provided by his caregiver, *ICC(A,1)* = .10, $p = .13$.[1] These correlations fell well outside of the range of performance exhibited by controls (10.6 *SDs* and 9.6 *SDs* below the mean of controls, respectively). In striking contrast with JS's inconsistent self-ratings, results showed that JS' test-retest ratings of his caregiver were reliable (i.e. fell within 2 *SDs* of the mean of controls), *ICC(1)* = .58 ($p < .001$), and correlated strongly with his caregiver's self-ratings (*ICC(A,1)* = .65, $p <.001$). EC's consistency and accuracy of self- and other-knowledge fell well within the normal range.

Table 4. Self- and other-person knowledge measures for J.S., E.C., and normal controls

	Self-Knowledge		Other-Person Knowledge	
	Consistency[a]	Accuracy[b]	Consistency[c]	Accuracy[d]
J.S.	-.02	.10	.58	.65
E.C.	.85	.74	.82	.73
Controls[e]	.84 (.08)	.73 (.07)	.81 (.20)	.67 (.16)

[a] *ICC(1)* between participants' self-ratings at two points in time
[b] *ICC(A,1)* between participants' self-ratings and informants' ratings of participants
[c] *ICC(1)* between participants' other-person ratings at two points in time
[d] *ICC(A,1)* between participants' other-person rating and informants' self-ratings
[e] *M* (*SD*)

V. Discussion

The present case study showed that an individual exhibiting confabulations for 10 years, J.S., was inconsistent in rating himself in a list of personality traits on two

[1] The correlation between J.S.'s self-ratings at timepoint 2 and his caregivers' ratings was significant, *ICC*(A,1) = .25 ($p < .05$), but fell well outside of the normal range (7.4 *SDs* below the mean of controls).

occasions spaced a week apart. Additionally, neither of J.S.'s ratings corresponded to his caregiver's ratings of him. On the other hand, JS was able to consistently rate his caregiver on two occasions and those ratings were similar to those of his caregiver's self-ratings. These results suggest that JS has an inconsistent sense of who he is: his self-ratings were extremely variable across occasions and bore little relation to the ratings made by another person, who has known him well for over 5 years. These findings should be interpreted with caution, since they are based on the observation of a single confabulating patient. Nevertheless, they are compelling. Several aspects of his performance are discussed below.

A. Impaired self-knowledge

First, the fact that J.S.'s ratings of his caregiver were consistent indicates that his inconsistent self-ratings cannot be explained by a general inconsistency in performance or an inability to judge personality traits in general. Instead, the inconsistency seems to relate specifically to J.S.'s knowledge of himself.

There are probably a variety of ways in which to interpret these findings. One possibility is that J.S. completely lacks a sense of who he is. Although this explanation cannot be discounted based on the current evidence, this is somewhat unlikely given the fact that J.S. seemed to have no difficulty in performing the task and appeared very engaged in it. We would expect that someone with a lack of sense of self would be at a loss when asked to describe himself and would probably either refuse to complete the task or be reticent in his approach.

It may be the case that J.S. has more than one self-representation based on information available from different lifetime periods, and he lacks the ability to segregate these selves temporally. This would be consistent with temporal theories of confabulation (Dalla Barba 1993a, 1993b; Schnider et al. 1996; Schnider, 2003), which assert that confabulations may be the result of difficulties in the temporal placement of memories. The case of patient PS (McCarthy and Hodges, 1995), who persistently and incorrectly claimed that he was home from the Navy on leave from active duty, is an example of the striking temporal confusion that may be exhibited by some confabulatory patients. A related explanation, which would be consistent with source monitoring theories of confabulation (Johnson et al., 1993, 1997), is that J.S.'s ability to determine the source of potentially different self-representations is impaired. These different self-representations may include accurate representations misplaced in time, as well as representations of an ideal or imagined self. J.S. may also have a retrieval deficit that may have resulted in the selection of different "selves" in memory in the two instances JS was asked to rate his personality, or even in the retrieval of more than one self-representation within a given instance. An alternative explanation of J.S.'s inconsistency in rating himself over time is that this inconsistency represents state changes rather than trait changes in J.S.'s self-representation. However, based on data from controls and E.C., it appears to be the case that adjectives on the personality questionnaire seem to induce people to access trait self-knowledge rather than assess their current state.

A case study reported in the literature (Conway & Tacchi, 1996), which did not assess consistency of personality ratings, found that a confabulatory patient rated herself as she used to be approximately one year post onset of symptoms. Unfortunately, we could not recruit someone who knew J.S. before the incident that led to his confabulatory syndrome, and thus we could not acquire ratings of JS's premorbid personality. Notwithstanding, if J.S. did select different self-representations at different timepoints, neither appears to be similar to the way he is perceived by someone who reportedly knows him well at the present time. Thus, it appears to be the case that JS does not have an updated or current sense of self. Instead, his sense of self could be characterized as transient at best.

B. VMFC and self-referential processing

Studies in amnesic patients have shown that trait self-knowledge may be preserved in the face of amnesia (Klein, et al., 1996; Klein et al., 2001; Tulving, 1993). In the present study patient E.C., who exhibited comparable memory impairment to JS but intact frontal function, showed both consistent and accurate knowledge of self. The memory impairment exhibited by E.C. is better characterized as the result of damage to medial temporal lobe structures. On the other hand, J.S.'s memory impairment stems mainly from damage to PFC, including VMPFC. These findings are consistent with results of neuroimaging studies (for a review see Northoff, et al., 2006), which demonstrate medial frontal involvement in self-referential processing, and suggest that the VMPFC plays an important role in the processing of information related to the self. We do not know at this point whether its role is in the acquisition, storage or retrieval of information about the self.

C. Preserved other-person knowledge

J.S.'s reliable and valid description of his caregiver's personality traits suggests that J.S. knows his caregiver. Alternatively, J.S. could have rated his caregiver on the basis of general semantic knowledge about male nurses. Nurse P may have fit the stereotype and thus rated himself in a similar fashion. To test this hypothesis we decided to show J.S. a picture of a male nurse he had never met, and ask him to rate this nurse on the same list of personality traits. We hypothesized that if J.S. had rated his caregiver on the basis of general semantic knowledge, but did not really know who his caregiver was, he would rate the "lure" nurse in a similar fashion. Given J.S.'s tendency to false alarm, we expected him to say he knew the lure once we showed him his picture and to have no difficulties completing the rating task, as it had been the case in the past. Surprisingly, this was not the case.

Two months after J.S. had rated his caregiver, we presented to J.S. the picture of the lure nurse, told him this was a male nurse and that we would like for him to rate the nurse on a list of personality traits. JS looked at the picture for a few seconds and said "I'm sorry, but I don't know him". Even after repeated encouragement of the experimenter, JS emphatically denied ever meeting the lure nurse and added "…but I do know a male nurse, nurse P. I can do the questionnaire about him". The conversation went on as follows:

JS: "…I met him up here, I come here often"

Experimenter: "Why do you come here?"

JS: "I come to identify how to stop being an alcoholic. I come here because I don't want to go to AA meetings. My wife is also an alcoholic, she's part Korean and part Japanese, she comes here too…"

Experimenter: "How did you meet nurse P?"

JS: “I don’t remember how I met him, it was 4 or 5 years ago, but I like him very much. He and I identify quite a bit. We grew up in the same environment and I have to respect him for what he does.”

Experimenter: “How are you and he alike?”

JS: “P‘s grandfather was rich and so was mine. We both have equal education, although he thinks I am smarter, and we’ve both traveled. I trust him, we converse a lot”

Although J.S.’s report was filled with confabulations, the fact that J.S. denied knowing the lure nurse and that he mentioned nurse P specifically, leads us to believe that he did not complete the questionnaire about his caregiver’s personality based on general semantic knowledge, but that in fact he knows his caregiver’s personality traits.

These findings suggest that J.S. has the ability to acquire person knowledge, since he only met his nurse after the onset of his memory problems and confabulation.

That he was able to consistently and accurately rate his caregiver is remarkable given the degree of his memory deficit, but not surprising based on previous findings in amnesia showing that individuals with profound memory deficits can acquire new semantic information (e.g. Glisky, 1992, Glisky & Schacter, 1987, 1988, 1989; Glisky, Schacter & Tulving, 1986a, 1986b; Vargha-Khadem, Gadian, & Mishkin, 2001). In contrast with other case studies reported in the literature, however, we found that an individual with severe memory impairment and compromised MPFC learned the personality of another person that he met postmorbidly. Patient K.C. and patient K.R. both showed valid other-person knowledge when asked to rate someone who they knew premorbidly (i.e. his mother and her daughter). On the other hand, patient K.R. was unable to rate a person she had met postmorbidly (i.e. her caregiver). Similarly, patient D.B. (Klein, Rozendal &

Cosmides, 2002) showed consistent and accurate self-knowledge, but impaired other-person knowledge when asked to rate his daughter.

But, why would J.S. be able to acquire other-person knowledge but not knowledge of his own personality traits? One explanation is that self-and other person knowledge are represented independently in memory, and that the VMFC mediates specifically the processing of information about the self. Klein and colleagues (2002) argue that D.B.'s performance is indicative of knowledge of self being functionally independent from other memory systems. This case study along with ours on J.S. appear to represent a double-dissociation between self and other-person knowledge, which is consistent with the hypothesis that these two types of knowledge may be represented independently in memory. However, an important distinction between Klein and colleagues' study and ours appears to be that they were exploring person knowledge acquired premorbidly, while we explored person knowledge acquired postmorbidly.

Given the lack of specific findings on CT scan in D.B., not much can be said about localization of function based on a comparison with this case. Imaging studies have shown that the processing of information about others, especially close others, may be mediated by similar brain structures as those engaged in self-referential processing (for a review see Amodio & Frith, 2006; Gillihan & Farrah, 2005). The few studies that have directly contrasted trait self-knowledge to other-knowledge (Craik et al., 1999; Heatherton et al., 2006; Kelley et al., 2002; Ochsner et al., 2005; Schmitz et al., 2004) have not been conclusive. They have indicated, however, that MPFC and right PFC in some cases shows increased activation when self-processing is contrasted to other-processing. Interestingly, similar brain areas were compromised in J.S.

Nevertheless, maybe a more important distinction between knowledge about oneself and about someone else in the case of J.S., is the time when this knowledge was acquired. J.S. has been potentially acquiring knowledge of himself pre and post morbidly, while knowledge about nurse P was only acquired postmorbidly. Moreover, although we could not assess whether J.S.'s personality had changed since the onset of his confabulation, this may have been the case. Patients who exhibit confabulation after survival of AcoA aneurysms, usually also exhibit personality changes and an amnesic syndrome, i.e. "ACoA syndrome" (Gilboa & Moscovitch, 2002). If J.S.'s personality has changed, this may add a degree of difficulty in acquiring and retrieving knowledge of self.

D. Implications for motivational accounts of confabulation

Some motivational accounts of confabulation have proposed that the concept of self may place constraints on the content of confabulation. In the present study we found that a long time confabulator did not have a consistent or accurate sense of self. At best his self concept was of a fleeting nature. This transient self may still constrain memory output at a given moment in time, but would not do it in a consistent manner. It may also be the case that a given concept of self becomes available more often than others, and this may explain why certain themes appear to repeat themselves in confabulation.

Consistent with results from previous studies indicating a positive bias in confabulation (Fotopoulou et al., 2004; Turnbull et al., 2004), J.S. endorsed more positive than negative traits as self-descriptive. Nonetheless, he did not do so more than controls or E.C. These findings are in contrast with findings by Fotopoulou and colleagues (2007) indicating that a group of confabulating patients were more likely than a group of patients with amnesia to incorrectly recognize more pleasant than unpleasant events. Although J.S. showed a positive bias in his self description, controls and a memory-impaired patient did so as well.

To sum up, a patient exhibiting confabulations did not seem to know his own postmorbid personality, i.e. did not have a consistent or accurate sense of self. At best, it may be argued that he has a transient sense of self. It is remarkable, however, that he seems to have been able to learn the personality traits of his caregiver. Replication of these findings and extension of this line of research in confabulatory patients may have important implications for theories of confabulation. Moreover, they could have implications for healthcare professionals and family members of these individuals regarding the best way to relate to the confabulatory patient.

STUDY 2: SELF-KNOWLEDGE IN ALZHEIMER'S DISEASE AND MILD COGNITIVE IMPAIRMENT

I. Background: Alzheimer's Disease and Mild Cognitive Impairment

Dementia is a clinical syndrome characterized by deficits in memory and other cognitive functions, which impair social or occupational functioning (American Psychiatric Association, 2000). AD is the most common type of dementia, accounting for 60% or more of all dementing illnesses (Alzheimer's Disease and Related Dementias Guideline Panel, 1996). There are two sets of similar criteria for diagnosing AD: those listed by the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition-Text Revision (DSM-IV-TR, American Psychiatric Association, 2000), and those set forth by the NINCDS-ADRDA (McKhann, et al., 1984). Both require that in order to be diagnosed with AD, a person shows progressive deficits in at least two cognitive functions, including memory, which impair the person's functioning. Thus, patients with AD by definition show impairments in multiple cognitive domains.

The neuropathology of AD consists of neuritic plaques, neurofibrillary tangles, and neuronal loss. Although there are variants of AD, the focus of the neuropathology of AD typically begins in the MTLs (including hippocampus, entorhinal cortex, and subiculum). With disease progression other brain areas, such as frontal, parietal, and lateral temporal regions, become increasingly compromised. There is also neuronal loss in subcortical brain regions, including the nucleus basalis of Meynert and locus ceruleus, which are a major source of neurotransmitter projection (cholinergic and noradrenergic, respectively) to widespread cortical areas. Eventually, gross cerebral atrophy occurs as a result of diffuse loss of neurons (Kaszniak, 2002).

The typical neuropsychological profile in AD involves memory difficulties early in the course of the disease, characterized by impaired acquisition of information and rapid forgetting. This is consistent with the early focus of neuropathology in the MTLs. Also relatively early decreased verbal fluency (especially semantic fluency) becomes apparent. As the disease progresses other cognitive functions show deficits, such as spatial orientation, visuospatial abilities, facial recognition, language, attention and executive function. Additionally, behavioral changes, agitation, and poor awareness may occur. The increasing executive function and behavioral problems appear to reflect changes in the frontal lobes (Kaszniak, 2002).

AD has been shown to have a long pre-clinical course. The term MCI emerged to characterize the transitional stage of cognitive impairment between normal aging and early stages of AD. However, individuals with MCI also show poorer health, and more often have cerebrovascular disease, disability, and depressed symptoms than those individuals with normal memory functioning. Thus, MCI does not always indicate preclinical AD (Kaszniak, 2002).

According to the criteria set forth by the American Academy of Neurology (Petersen, Stevens, Ganguli, Tangalos, Cummings, & DeKosky, 2001) MCI refers to the clinical presentation of individuals who show impairments in memory, but otherwise normal cognitive function, and show intact activities of daily living. More recently, the concept of MCI has been expanded to include other cognitive deficits. As a result, three subtypes of MCI have emerged: amnestic, multiple domain, and single non-memory domain. Amnestic MCI is the new term used to describe the clinical presentation originally referred to as MCI (and listed above). Multiple domain MCI, as the term implies, involves deficits in various cognitive domains. The presence or absence of memory problems in individuals with multiple domain MCI, gives rise to the distinction between multiple domain MCI with or without amnesia. The least common type of MCI is the single non-memory domain MCI, in which individuals present with impairment in one cognitive domain other than memory.

Most of the research with MCI has included subjects with amnestic MCI. A number of studies have found that individuals diagnosed with MCI are at increased risk for developing AD and other dementias when compared to age-peers in the general population (for a review see Petersen, 2004). Furthermore, different clinical subtypes of MCI may represent prodromal forms of different dementias and other conditions. Amnestic MCI and multiple domain MCI with amnesia are likely to progress to AD, while other subtypes may progress to other non-AD dementias (Petersen, et al., 2007).

In our previous study, our patient with AD (EC) showed both a consistent and accurate sense of self. Furthermore, he seemed to have consistent and accurate knowledge of his daughter. A previous case study reported in the literature (Klein, et al., 2003) had shown that although a patient with AD (i.e. K.R.) showed a consistent sense of self, this knowledge seemed to be from her premorbid self. An important difference may be that EC was in the early stages of the disease process, while K.R. was in an advanced stage, as indicated by her cognitive performance. Moreover, according to the ratings by

K.R.'s daughter of the patient pre and postmorbid personality, K.R.'s personality had changed since the onset of memory problems. We asked EC's daughter to rate him before the onset of memory problems on the same list of traits, and she did so in a very similar fashion as when she rated his current self. This suggests that EC's personality had not changed at that point. As the disease progresses the ability to do a variety of tasks is compromised in individuals suffering from the AD. These functional changes and the commonly accompanying lifestyle and role changes, might affect an individual's sense of self. Simultaneously, frontal areas of the brain become affected with the advancement of the disease, which may directly result in impairments in self-knowledge. Study 2 begins to test these hypotheses.

II. Methods

A. Participants

Ten patients diagnosed with AD according to NINCDS-ADRDA criteria (seven males) were recruited as participants, through the pool enrolled in the Arizona Alzheimer's Disease Clinical Core (ADCC) and from the community. AD diagnosis was made by a neurologist based on clinical examination and neuropsychological assessment results. All AD patients met criteria for mild AD (Mini Mental State Exam [MMSE] = 17-23). We also had a group of ten participants (5 males) with amnestic MCI or multiple domain MCI with amnesia, recruited from the pool enrolled in the ADCC and from the community. Participants were classified as having MCI according to criteria put forth by the American Academy of Neurology (Petersen, et al., 2001). Thus, participants with MCI did not show impairment of function in activities of daily living, but showed low memory performance on formal memory testing (memory factor < -1 *SD* relative to the normative group of older adults).

Ten normal controls (4 males) were recruited through our pool of healthy community-dwelling older- adults, who had undergone neuropsychological assessment within two years of experimental testing. Controls for this study had factor scores equal or greater than -.55 *SDs* from the mean of the normative group. Table 5 shows descriptive statistics for patients and controls. A between subjects ANOVA on age and level of education showed no significant differences between controls and each of the patient groups ($Fs \leq 1$). A between subjects ANOVA on MMSE, frontal and memory factor, and semantic fluency scores (i.e. number of words generated in one minute for two semantic categories: animals, and fruits and vegetables) revealed groups differed significantly on these measures ($ps < .001$). Subsequent t-tests revealed that the control group scored significantly higher than the MCI group, which in turn scored higher than the AD group on MMSE, and frontal and memory factor scores ($ps < .05$). AD and MCI patients did not significantly differ from each other on semantic fluency measures ($p = .12$), but both patient groups scored significantly lower on this measure than controls ($ps < .001$).

We also had three groups of informants, one for each of the patient groups and one for the controls. Informants were relatives or friends of patients and controls, who reported knowing the patient very well. All informants denied a history of dementia or stroke, alcohol or substance abuse within the past two years, or current untreated psychiatric illness. We were unable to recruit informants for two of our MCI patients.

Table 5. Mean descriptive statistics (*SDs*) for AD and MCI patients, and controls

Participants	N	Age	Education	MMSE	Memory Function[a]	Frontal Function[a]	Semantic Fluency
AD	10	78.60 (3.89)	15.10 (3.96)	21.20 (1.55)	-2.88 (0.64)	-1.30 (0.70)	16.70 (6.80)
MCI	10	80.80 (7.21)	15.20 (2.57)	26.50 (2.55)	-1.61 (0.51)	-0.57 (0.53)	21.10 (5.06)
Controls	10	77.80 (5.85)	15.50 (2.67)	29.30 (0.48)	0.22 (0.39)	0.39 (0.41)	36.50 (7.26)

Note. [a] *z* scores (see text).

Five spouses, three children, and two friends/caregivers (all females; age *M* = 68.20, *SD* = 15.45; education *M* = 16.00, *SD* = 3.02) comprised the group of informants for the AD patients; five spouses, one child, and two friends (seven females; age *M* = 75.25, *SD* = 13.83; education *M* = 15.13, *SD* = 1.73) comprised the group of informants for the MCI patients; and six spouses and four friends (six females; age *M* = 74.80, *SD* = 3.97; education *M* = 15.20, *SD* = 2.20) comprised the informants for the control group. Informants of ADs, MCIs and controls reported that they have known participants for a mean of 46.80 (*SD* = 12.12), 47.50 (*SD* = 22.43) and 32.10 (*SD* = 21.56) years, respectively. A between subjects ANOVA on age, years of education, and number of years that informants had known participants revealed that the groups of informants did not differ significantly on any of these variables (all $Fs \leq 2.01$, $ps \geq .16$).

B. Materials and Procedure

Participants were assessed individually. ADs, MCIs and controls participated in two sessions and informants in one session.

<u>Neuropsychological Assessment.</u> Informants of AD patients provided general background and medical information about the patient and themselves. Controls and their informants provided general background and medical information about themselves. Patients recruited through the ADCC had received a battery of neuropsychological tests that included some of the tests required to calculate the factor scores (i.e. Logical Memory I Story A, Controlled Oral Word Association Test and Digit Span) and semantic fluency. They also completed the additional neuropsychological tests that were necessary to compute the factor scores. Patients recruited from the community completed only the

tests comprising the factor scores, the MMSE, and semantic fluency measures. Controls recruited through the pre-existing database at the Amnesia and Cognition Unit had completed tests necessary to compute the factor scores as well as other cognitive measures, including the MMSE and semantic fluency measures.

Assessment of Self-Knowledge. We used the personality trait questionnaire described above to test self- and other-person knowledge. Patients and controls were asked to indicate how well each trait described them and their informant on two separate occasions, spaced a week to 10 days apart. The same adjectives, but in a different order, were presented on each occasion. One AD patient dropped out from the study after completing all aspects of the study, except the second set of questionnaires.

Informants of patients and controls rated how well each trait described the patient (or control) at the present time. Immediately after, informants of patients were asked to complete the same questionnaire, but with adjectives in a different order, and were asked to report how well each trait described their relative before the onset of memory problems. Four of the eight informants of MCI patients stated that they would rate the patient exactly the same way as currently. Hence, those informants did not complete this questionnaire. Finally, informants of patients and controls rated how well each trait described them.

III. Results

A. Consistency and Accuracy of Self- and Other-Person Knowledge

Consistency and accuracy of self- and other-person knowledge were measured in a similar fashion as in Study 1. Table 6 shows mean statistics on these measures for each group.

Table 6. Self- and other-person knowledge measures for AD and MCI patients, and controls.

Participants	Self-Knowledge		Other-Person Knowledge	
	Consistency[a]	Accuracy[b]	Consistency[c]	Accuracy[d]
AD	.68 (.21)[f]	.44 (.18)[g]	.83 (.16)[f]	.64 (.24)[g]
MCI	.73 (.17)[g]	.67 (.13)[e]	.79 (.18)[g]	.73 (.12)[e]
Controls	.87 (.05)[g]	.76 (.05)[g]	.85 (.14)[g]	.69 (.13)[g]

Note. *M* (*SD*)
[a] *ICC(1)* between participants' self-ratings at two points in time
[b] *ICC(A,1)* between participants' self-ratings and informants' ratings of participants
[c] *ICC(1)* between participants' other-person ratings at two points in time
[d] *ICC(A,1)* between participants' other-person rating and informants' self-ratings
[e] n = 8
[f] n = 9
[g] n = 10

A between subjects (AD, MCI, and controls) ANOVA on consistency and accuracy of self- and other-person knowledge, showed significant group differences on consistency, F (2, 26) = 3.88, $p < .05$, and accuracy of self-knowledge, F (2, 25) = 15.41, $p < .001$. None of the comparisons regarding other-person knowledge were significant ($Fs \leq .37$, $ps \geq .52$). Subsequent t-tests showed that AD and MCI groups did not differ significantly in self-consistency measures, t (17) = -.49, p = .63, but they were both less consistent in rating themselves than normal controls, *t* (17) = -2.74, *p* <.05, and *t* (18) = -2.62, *p* <.05, respectively. Additionally, AD patients were less accurate in rating themselves than both MCI patients and controls, *t* (16) = -3.04, *p* <.01, and *t* (18) = -5.39, *p* <.001, respectively; but MCI and controls did not differ in terms of accuracy of self-ratings, *t* (16) = -1.92, *p* = .07.

In order to assess whether patients' trait characteristics had changed since the onset of memory problems, ICCs(1) were computed between informants' ratings of the patients' personality traits currently and premorbidly. There was considerable variability within the AD patient group with values ranging between .31 and .82 (see column 1, Table 7), indicating that, as per informants' report, some AD patients had shown changes in personality, while others did not. In contrast, MCI patients did not seem to exhibit changes in personality, with correlations between informants' ratings of pre- and post-morbid personality traits ranging from .74 to .86.

Pearson product-moment correlation coefficients were computed between consistency and accuracy of AD and MCI patients' self-knowledge, and change in patients' personality as rated by informants. Change in personality was marginally related to accuracy of self-knowledge (*r* = .51, *p* =.06), but not consistency of self-knowledge (*r* = -.35, *p* = .24). These results indicate that patients whose personality had changed since the onset of memory problems (as reported by informants) tended to show a sense of self that was different from what their informants reported.

Table 7. Individual AD patients' data on self- and other-person knowledge measures

Participants	Personality Change	Self-Knowledge			Other-Person Knowledge	
		Consistency[b]	Accuracy[c]	Premorbid[d]	Consistency[e]	Accuracy[f]
AD1	.77	.85	.74	.78	.82	.73
AD2	.73	.75	.60	.66	.97	.96
AD3	.58	.79	.58	.77	.88	.84
AD4	.31	.76	.21	.83	.76	.51
AD5	.32	.77	.29	.81	.93	.50
AD6	.49	.80	.49	.65	.92	.88
AD7	.58	.65	.38	.47	.88	.68
AD8	.69	.62	.50	.27	.87	.25
AD9	.82	.15	.17	.18	.44	.29
AD10	.49	--	.39	.51	--	.71

[a] *ICC(1)* between ratings of patient by informant pre- and post-morbidly
[b] *ICC(1)* between patient's self-ratings at two points in time
[c] *ICC(A,1)* between patient's self-ratings and informant's ratings of patient currently
[d] *ICC(A,1)* between patient's self-ratings and informant's ratings of patient before the onset of memory problems
[e] *ICC(1)* between patient's other-person ratings at two points in time
[f] *ICC(A,1)* between patient's other-person ratings and informant's self-ratings

Table 7 shows individual data for AD patients on self- and other-knowledge measures. We considered that the personality of a particular AD patient had changed if the ratings made by informants of the patient's personality pre- and post-morbidly was more than two *SDs* below the MCI group mean (MCI group $M = .79$; $SD = .05$). Regarding consistency and congruency of self- and other-person knowledge, we considered abnormal values that fell more than two *SDs* below the mean of our group of participants in the MCI and control group together (self-consistency $M = .80$, $SD = .14$; self-accuracy $M = .72$, $SD = .11$; other-person consistency $M = .82$, $SD = .16$; other-person accuracy $M = .71$, $SD = .13$).

The first two AD patients presented on Table 7 (AD1 and AD2) had not exhibited changes in personality as reported by informants. These two patients showed consistent and accurate self-and other-person knowledge In contrast, patients AD3 to AD7 appear to have changed personality. This subgroup of patients rated themselves and their informants consistently across two sessions, and were able to rate their informant accurately, but 4 of the 5 patients were unable to rate themselves as their informants rated them. Upon visual inspection of the data, it becomes evident that current self-ratings by patients AD1 to AD7 appear to be closer to their premorbid personality ratings (as reported by informants). Moreover, this pattern of performance becomes more evident in patients whose personality has changed since the onset of memory problems, as per their informants' report. Data for patients AD8, AD9 and AD10 is difficult to interpret because they show inaccurate other-person knowledge, inconsistent ratings and missing data, respectively. However, it is worth noting that AD9 was the patient with the lowest level of cognitive performance (memory factor = -3.90, and frontal factor = -2.46). In a previously published case study of a moderately impaired AD patient (Klein, Cosmides, & Costabile, 2003) the patient was asked to complete the personality questionnaires by answering "yes" or "no". In our study we used a 4-point scale, which may have resulted in the task being too difficult for the patient to complete.

B. Self- and Other-Person Knowledge and Cognitive Function

Pearson product-moment correlation coefficients were computed between self and other-person knowledge measures and performance on tests of cognitive function (i.e. MMSE, frontal factor and memory factor, and semantic fluency scores) for all participants. Neither of the other-person knowledge measures was related to our measures of cognitive function, and so these are not considered further. The correlations are shown in Table 8. Given the number of correlations of interest, there is an increased probability of a Type I error. Hence, *p* values were set at .01. As shown in Table 8, consistency of self-knowledge was significantly correlated with frontal and memory function, while accuracy of self-knowledge was significantly correlated with all measures of cognitive function (i.e. MMSE, frontal and memory factor, and semantic fluency).

Given the large number of intercorrelations, and in order to elucidate factors that would have the most explanatory value, we computed a stepwise multiple linear regression analysis on accuracy of self-knowledge for all participants. Of possible predictors in the regression analysis on accuracy of self knowledge (MMSE, frontal factor, memory factor and semantic fluency), frontal function (adjusted R^2 = .64), and MMSE scores (R^2 change = .08) showed a significant association with accuracy of self-knowledge, F (2, 27) = 33.53, $p < .001$ (adjusted $R^2 = .71$). A similar stepwise multiple linear regression analysis on consistency of self-knowledge, indicated that frontal function was significantly associated with consistency of the self-representation, F (1, 27) = 22.99, $p < .001$ (adjusted $R^2 = .44$), with none of the other factors (i.e. MMSE, memory factor and semantic fluency) significantly accounting for the remaining variance.

Table 8. Intercorrelations among Self-Knowledge and Cognitive Function

	1	2	3	4	5	6
1. Consistency SK	--	.71**	.44*	.68**	.52**	.42*
2. Accuracy SK		--	.79**	.81**	.75**	.68**
3. MMSE			--	.74**	.81**	.68**
4. FFAC				--	.80**	.73**
5. MFAC					--	.78**
6. Semantic Fluency						--

Note. FFAC = frontal factor; MFAC = memory factor; MMSE = Mini Mental Status Exam; SK = self-knowledge.
**p* <.05, two-tailed. ***p* <.01, two-tailed.

IV. Discussion

The present study found that a group of AD patients were less congruent with their informants in rating themselves than a group of MCI patients and a group of controls, but not in rating another person they knew well. Thus, inaccuracies in self-ratings cannot be accounted for by a general lack of person knowledge in patients, or difficulties in completing the task at hand. The fact that ratings of other-person knowledge were valid, along with informants' report that they knew patients very well and had known them for an average of 46 years, leads us to believe that discrepancies between patients' and informants' ratings are not the result of informants and patients not knowing each other well enough.

AD patients showed varying degrees of changes in personality as indicated by informants, but MCIs did not. AD patients who showed changes in personality tended to also be less congruent with informants in rating their current self, but instead rated themselves as they used to be. This finding is consistent with findings from the only published case study that we are aware of that explored self-knowledge in AD (Klein et al., 2003). Thus, it appears to be the case that AD patients are not able to update their sense of self, and may be operating from knowledge of a former self.

Frontal function and an overall measure of cognitive function (i.e. MMSE) were found to be significant predictors of accuracy of self-knowledge in the present study. One possible explanation for these results is that with disease progression, patients exhibit changes in personality. These personality changes may be a direct result of certain brain areas (i.e. frontal lobes) becoming increasingly compromised with disease progression, and/or the result of a progressive decline in functioning, which is reflected by lower scores in our overall measure of cognitive function. Thus, when people that know patients well are asked to rate patients' personality pre- and post- morbidly, they rate patients as different on the two occasions. However, when patients are asked to rate themselves they do so as they used to be, and thus their ratings of current self are inaccurate.

But, why would AD patients be unable to update their self-knowledge when other amnesic patients have been found to be able to do so? One answer to this question may be related to the etiology of memory impairment. In patients with episodic memory deficits as a result of an acute event (e.g. TBI or stroke), cognitive and functional deficits are relatively stable through time. These patients may acquire knowledge of their personality traits (based on a semantic memory system) over time after sufficient repetition of specific personal events involving those traits. This is consistent with findings from our previous study in patients with stable memory impairment, which found that time since injury was related to consistency of patient's self-representation. AD, on the other hand, is characterized by a progressive decline in functioning, which may lead to continuous changes in behavior over time. The repetition of a person's behavior, exemplifying that individual's personality traits, may be crucial for the acquisition of semantic knowledge about self in amnesics. If this was the case, then patients with AD, whose behavior may change over time, may not be able to update their sense of self. The previous study presented in the literature with an AD patient (Klein et al., 2003), showed that this patient was not only unable to update her sense of self, but was also unable to acquire new other-person information. Hence, it may be the case that AD patient's inability to update their sense of self is an instance of a more general deficit in acquisition of new semantic information.

Similarly, it may be the case that the general breakdown in semantic memory, which is typically seen in AD patients and was demonstrated in our group of patients, is responsible for inefficiencies in the acquisition of new semantic information, such as personality trait knowledge. In the present study, inaccurate self-knowledge was related to the presence of semantic memory deficits. However, results from our regression analysis on accuracy of self-knowledge, indicated frontal function and MMSE scores were better predictors than semantic memory.

We did not look at the relation between time since onset of AD and accuracy of self-knowledge for a number of reasons. First, in AD it is more difficult to acquire an accurate estimate of onset of cognitive difficulties given that it is a relatively slow progressive disorder. It is often difficult to select a specific point in time when the disease began. Time of diagnosis could be one, but it is affected by a number of variables that are not necessarily related to the actual time of onset of the disease, such as accessibility of service. Additionally, because AD is a progressive disorder the passage of time since the onset of disease is confounded with the progression of memory and other cognitive difficulties.

Another finding of interest was that MCI and AD patients were significantly less consistent than a group of controls in rating themselves, but not in rating another person they knew well. Given that there were no group differences in consistency of other-person knowledge, group differences in consistency of self ratings cannot be explained by an overall inconsistent performance in patients. The fact that AD patients showed some inefficiency in consistently rating themselves is not surprising in light of other findings of self-knowledge presented above. It is somewhat surprising, however, that MCI patients showed less consistent self-representations than controls, in the face of a lack of difference in the consistency of other-person representation. In our group of participants, frontal function was found to be related to consistency of self-knowledge, but not to consistency of other-person knowledge. This is in line with our and others' previous findings that frontal brain regions are involved in the processing of self-related information. It could also be the case that patients' less consistent ratings are a true assessment of their current personalities, which are somewhat less consistent on a day to day basis than that of normal controls as a result of the disease process, and informants are unable to notice this.

Findings from the present study showing impaired self-knowledge but preserved other-person knowledge in AD patients may be interpreted as evidence in support of the view that the self is special relative to other-person processing. Nevertheless, in our study, patients' personalities seemed to have changed since the onset of memory problems, while there are no reasons to believe that informants' personalities had changed. Thus, if we were to compare patients' accuracy of current self-knowledge to accuracy of other-person knowledge, we would be comparing the acquisition of new information about the self (acquired post-morbidly) to information acquired premorbidly about another person. Hence, the better comparison may be between patients' knowledge of their premorbid selves to other-person knowledge. Both of these appear to be preserved in AD.

STUDY 3: SELF- AND OTHER-REFERENTIAL PROCESSING IN MEMORY-IMPAIRED PATIENTS AS A RESULT OF ACQUIRED BRAIN DAMAGE

I. Background: Neuropathology and Cognitive Functioning after Acquired Brain Damage

Study 3 included a group of patients who presented with memory deficits following a specific incident that resulted in brain damage. Most patients in our group of participants had suffered a TBI, an anoxic event or rupture of the ACoA. In what follows I will review these three neurological conditions. Memory impairments and other cognitive deficits associated with them are usually particularly severe immediately following the event, with most recovery occurring during the first year following injury. However, after this first year cognitive deficits tend to remain relatively stable.

The most common cause of TBIs in adults is motor vehicle accidents (Kolb & Whishaw, 2003). Damage to the brain in a motor vehicle accident is usually a result of closed-head injury, which results from a blow to the head. Open-head injury can sometimes be present as well, if a sharp object penetrates the skull. Damage to the brain produced by a closed-head injury may be the result of a variety of primary and secondary processes. Primary processes can be subdivided in two categories: focal injury and diffuse injury. The main forms of focal injury (contusions) result from contact and acceleratory/deceleratory forces. First, there is damage at the site of the blow (i.e. coup). Coups are sustained when the brain is compacted against the skull by the bone's pushing inward. The pressure that causes the coup may push the brain against the back of the skull, producing an additional contusion, called countercoup. Diffuse axonal injury, the main form of diffuse injury, is the shearing of fibers caused by the movement of the brain as a result of acceleratory/deceleratory forces. In motor vehicle accidents the head is moving when the blow is struck, increasing the velocity of the impact and the number and severity of diffuse axonal injuries. Secondary processes causing damage to the brain after a motor vehicle accident include hemorrhage, hematomas, increased intracranial pressure, edemas and hydrocephalus, herniation, and intracranial infections (Kolb & Whishaw, 2003).

Ventral and polar frontal and temporal regions are particularly prone to focal damage due to coup/countercoup injuries because of the brain being compressed against the ridges and confines of the anterior and middle fossa. Damage to these structures tends to be bilateral. Diffuse axonal injury often results in more generalized impairment from widespread trauma throughout the brain, and may particularly affect large fiber tracts, especially those crossing the midline of the brain, such as the corpus callosum and anterior commissure (Lucas & Addeo, 2006).

The classic pattern of cognitive deficits after TBI include impairments in speeded information processing, attention, memory and executive functioning, corresponding with the diffuse, temporal and frontal injury. The pattern of memory deficits seen in patients with severe TBI will be determined by the combination of damage to both MTLs and frontal lobes, as well as damage to pathways to and from them. Damage to the MTL can result in the classic amnesic syndrome. More commonly, patients with TBI also show memory deficits typical of frontal lobe injury, i.e. impairments in working memory and source memory, deficits in the ability to utilize strategies that would direct encoding and retrieval, and increase in false recognition responses (Lucas & Addeo, 2006).

Anoxic brain injury results from reduced oxygen to the brain. Although the brain receives approximately 15% of the cardiac output, it does not store oxygen. A period of longer than 4 to 8 minutes of oxygen deprivation is likely to produce cerebral infarction and cell death. Specific brain areas are vulnerable to anoxic injury because of their physical location and their biochemical make-up (O'Connor & Verfaellie, 2002). Peripheral terminations of major cerebral arteries are the first to experience reductions in blood flow. Additionally, the metabolic demand of brain areas varies, and those that have a higher demand are more likely to be most affected by oxygen deprivation. Within these most vulnerable areas, different cell groups are also more likely to be affected. Although most attention has been focused on damage to the hippocampus following anoxia, the basal ganglia, watershed cortex, thalamus and cerebellum are also likely to be affected (Caine & Watson, 2000). A review by Caine & Watson (2000) of 67 individual case reports of cerebral anoxia indicated that the watershed zone of the cerebral cortex and the basal ganglia are the most common sites of damage. Damage to the hippocampus is also common, but isolated hippocampal damage occurred in only 18% of the cases. An amnesic syndrome was reported in 54% of the cases. The pattern of memory deficits varied among patients, likely due to which brain structures were affected and to what extent (Caine & Watson, 2000). Impairments in executive function and personality are also commonly seen in anoxic brain damage, and visuospatial and language deficits have also been reported (O'Connor & Verfaellie, 2002).

ACoA aneurysms can lead to brain damage as a result of hemorrhage, vasospasm, hematoma formation, herniation of the medial temporal lobes, hydrocephalus, and surgical intervention (O'Connor & Verfaellie, 2002). Given the area perfused by the AcoA and its branches, damage is usually seen in basal forebrain, striatal and frontal regions. Forty percent of patients who undergo repair of the ACoA aneurysms present with memory impairments and personality changes. Executive dysfunction and confabulation are also common (O'Connor & Lafleche, 2006). The pattern of memory deficits usually seen in ACoA is better characterized as the one typically seen as part of damage to the basal forebrain and frontal regions (O'Connor & Verfaellie, 2002).

II. Purpose and Hypotheses

There were four purposes to Study 3. First, we were interested in exploring self- and other-person knowledge in a group of memory-impaired patients with relatively stable deficits. Our previous study with a similar population (Marquine & Glisky, 2005) showed degree of self-knowledge varied across patients and was related to frontal function. Given that we did not have a control task, it was difficult to interpret this variability among patients. In the present study, other-person knowledge served as the control task. Moreover, exploring other-person knowledge in memory-impaired patients was intrinsically interesting to us. Secondly, we wanted to explore whether SR processing could be a viable memory rehabilitation strategy. Findings from our previous study indicated that SR processing can be a powerful encoding device for memory-impaired patients with disorders of varying severity. However, there was great variability in our sample, and the ability to show a SRE on memory seemed to be related to frontal/executive function. In the present research we attempted to replicate the findings of our previous study showing a SRE in memory-impaired individuals that was dependent on some degree of intact frontal function, and test the generalizability of this effect to more ecologically-relevant materials and testing situations. This is a crucial step in the development of memory rehabilitation strategies based on this effect. Third, we wanted to explore whether patients could show an improvement in memory as a result of OR processing. Studies in normal adults show that referencing information to a close other can result in memory improvements similar to those found after SR processing. However, to our knowledge, no studies have been reported in the literature exploring whether this is the case in memory-impaired individuals. Perhaps, if patients have a severe self-processing deficit, but are unimpaired in other processing, such as was the case in our confabulatory patient and a subgroup of our patients with AD, they might show an ORE that is greater than the SRE. Fourth, we began to explore potential mechanisms underlying the SRE. Cognitive explanations have focused on the notion that SR processing is more meaningful and elaborate thus representing a deeper level of processing, which is normally associated with better memory. An alternative argument—the emotional/ motivational perspective—asserts that the essential dimension is not the amount or type of knowledge employed in encoding the item but the person's emotional involvement in what he or she knows. We tested the viability of a cognitive explanation of the SRE by exploring the relation between memory enhancement as a result of SR and OR processing and degree of self- and other-knowledge, respectively. In our previous study with a group of 12 memory-impaired patients the correlation between the size of SRE and self-knowledge did not reach significance. In the present study we increased our sample size by also administering self-knowledge and SRE measures to controls in an effort to increase power. As a first step in exploring the feasibility of an emotional explanation of the SRE, we investigated whether the SRE was related to the extent to which people benefit from emotional processing.

There is ample evidence that supports the notion that emotion may lead to enhanced explicit memory in people without brain damage (for a review, see LaBar and Cabeza, 2006). Moreover, this emotion enhancement effect in memory has also been shown in a small number of studies with amnesic patients as a result of acquired brain damage (Burton, Bernstein Vardy, Frohich, Dimitry, Wyatt, Rabin, & Labar, 2004, Frank & Tomaz, 2003, Hamman, Cahill, McGaugh, & Squire, 1997; Hamman, Cahill, & Squire, 1997, Phelps, LaBar, & Spencer, 1997). Because most neuropsychological studies have been aimed at understanding the neural underpinnings of emotional memory, they have for the most part used participants with circumscribed brain damage, such as patients with temporal lobectomies (Burton, Bernstein Vardy, Frohich, Dimitry, Wyatt, Rabin, & Labar, 2004, Frank & Tomaz, 2003; Phelps, LaBar, & Spencer, 1997). However, to our knowledge no studies have been reported exploring whether this effect is apparent in individuals with memory impairment as a result of TBI. As reviewed above, TBI usually results in focal damage to medial frontal and temporal areas as well as diffuse brain damage. Elucidating whether these individuals can improve their memory as a result of emotional processing may contribute not only to a better understanding of the neurobiology of emotional memory, but also pave the way to novel memory rehabilitation methods.

Our hypotheses for the present study were as follows:

1. Given our previous findings with memory-impaired patients (Marquine & Glisky, 2005), we predicted that consistency and accuracy of self-knowledge would be variable in our group of patients, and related to frontal functioning. Given findings of Study 1 and Study 2, showing intact other-person knowledge in confabulation, AD and MCI, we predicted that our group of patients would show preserved other-person knowledge.
2. Based on prior findings (Marquine & Glisky, 2005), we predicted patients would show a SRE in memory. These results along with findings from studies on the ORE in individuals without brain damage, led us to hypothesize that an ORE would be evident in patients when a close other was used as referent during encoding.
3. If one of the mechanisms underlying a SRE was that the self is a very well organized and elaborate knowledge structure, it follows that the size of the SRE would be dependent upon degree of self knowledge (i.e. consistency and accuracy). We hypothesized this would be the case.
4. Given findings from previous studies exploring the effect of emotion on explicit memory in people with amnesia, we predicted that our group of memory-impaired patients would show an emotion enhancement effect in memory.
5. If emotion was another mechanism underlying the SRE, then the size of the SRE would also be related to the size of the emotion enhancement effect in memory.

III. Methods

A. Participants

Twelve memory-impaired individuals (five female) of mixed etiology and varying degrees of memory-impairment participated in the study. Patients were recruited through a pool of memory-impaired patients at the Amnesia and Cognition Unit and the community. All patients were at least one year post injury or incident, and did not have significant language problems. They also exhibited memory problems as a prominent neuropsychological deficit, revealed by General Memory Index scores from the WMS-III (Wechsler, 1997) that were at least one standard deviation below their "premorbid" intellectual functioning (North-American Adult Reading Test, NAART; Spreen & Strauss, 1998). Table 9 shows individual descriptive data (i.e. neuropsychological testing performance, and etiology and site of brain damage) for our patient group. We were able to acquire structural MRIs of the brains of five patients. The rest of the patients either did not qualify to undergo an MRI, or did not want to participate on this portion of the study. Information on lesion location for patients who did not have an MRI was gathered from imaging and neurological reports obtained from medical centers that patients had previously attended. Many of these reports, however, were outdated and may not be valid indicators of the current status of the patients' brain damage or atrophy.

Table 9. Patients' descriptive characteristics

Patient	Etiology	Location	IQ	GMI
PAT004[a]	TBI	r FL/Diffuse	125	96
PAT011[a]	TBI	FLs/TLs/Diffuse	109	74
PAT012[a]	TBI	r FL/r TL/Diffuse	125	110
PAT014[b]	Aneurysm	FLs	96	60
PAT015[b]	TBI	Diffuse/l TL	101	54
PAT016[b]	Aneurysm	r Thalamic/l PL	127	81
PAT023[a]	TBI	FLs (r > l)/rTL/Diffuse	110	98
PAT027[b]	Anoxia	Diffuse/TLs/ FLs	104	70
PAT029	TBI	--	104	86
PAT045[b]	Tumor	Diffuse/FLs/l PL	111	86
PAT054	TBI	---	122	92
PAT056[a]	TBI	FL (r > l), r TL, mid PL	104	69
Mean			112	81

Note. Etiology = etiology of brain damage; Location = location of brain damage; IQ = NAART FSIQ; GMI = General Memory Index score (WMS-III); TBI = traumatic brain injury; FL = frontal lobe; TL = temporal lobe; PL = parietal lobe; r = right; l = left.
[a] = patient underwent brain scan
[b] = report of scan available

We had a group of 12 normal controls (six female). Controls were recruited through a pool of community dwelling adults at the Amnesia and Cognition Unit and the community, and had no significant psychiatric or neurological history. Table 10 shows descriptive statistics for patient and control groups. An independent samples t-test on age and years of education revealed no significant differences between the patient and control group, $t(22) = -.15$, $p = .88$ and $t(22) = -.24$, $p = .81$, respectively.

We also had two groups of informants (one for patients and one for controls), who were individuals that patients and controls had stated they knew well, and who had no significant neurological or psychiatric history. We were unable to recruit informants for one patient and two controls. The group of informants for patients (n = 11) was comprised of three parents, five spouses, two other relatives, and one friend (Age *M* = 59.18 years, *SD* = 9.47; Education *M* = 14.64 years, *SD* = 3.11). Four of the 11 informants for patients had met the patient post-morbidly. The group of informants for controls (n = 10) was comprised of seven spouses, one other relative and two friends (Age *M* = 46.90 years, *SD* = 11.06; Education *M* = 15.90 years, *SD* = 2.23). An independent samples t-test showed that the group of informants for patients was significantly older than the group of informants for controls ($p < .05$), but there were no significant group differences on years of education.

Table 10. Mean descriptive statistics (*SDs*) for patients with acquired brain damage and controls

Group	N	Age	Education	NAART FSIQ	Memory Function[a]	Frontal Function[a]
Patients	12	47.08 (9.28)	14.50 (3.50)	112.26 (10.26)	-.62 (.58)	-.22 (.87)
Controls	12	47.67 (9.88)	14.83 (3.24)	111.48 (9.90)	.62 (.45)	.22 (.58)

Note. [a] *z* scores (see text).

B. Materials

Self- and other-person knowledge. The materials to assess self- and other-person knowledge were identical to the ones used in Study 2, except that the instructions for the questionnaire requesting informants to rate patients premorbidly were modified to fit the population of interest. Instructions asked informants to rate patients "before the incident" that resulted in patients' brain damage, instead of "before the onset of memory problems".

SRE and ORE. Three pairs of lists of 16 verb-noun phrases depicting actions in which people do not usually engage were created (e.g. *ride a camel*, *play the harp*). The two lists of each pair had the same verbs but different nouns (e.g., play the harp, play chess). One list of each pair was studied and the other served as distractor in the recognition memory test. None of the nouns comprising the phrases were listed as a first completion for its verb in a pilot study. Lists had a similar number of syllables and similar number of phrases with 4 syllables.

Emotion Enhancement Effect in Explicit Memory. Two lists of 28 sentences (for patients) and two lists of 84 sentences (for controls) were selected from a pool created by Davidson, McFarland, and Glisky (2006). The lists used for controls included the 28 sentences used for patients. Sentences in one of the lists for each group were used as target items during encoding, and sentences in the other list were used as distractor items in recognition testing. In Davidson and colleagues' (2006) study, the emotional (i.e. negative) and neutral sentences were rated during a pilot study for pleasure (from 1= very low to 9 = very high), arousal (from 1 = very low to 9 = very high), and concreteness (from 1 = very concrete to 9 = very abstract). The two lists used in our study for each group of participants were similar in length and ratings of concreteness. Half of the sentences in each list were chosen to be emotional (i.e., high in arousal;) and of negative valence, and half were neutral. According to ratings obtained by Davison and colleagues (2006), the group of emotional sentences used in our study for patients and controls were significantly more arousing (Arousal ratings *Ms* = 6.80 and 6.86, respectively) than the neutral sentences (Arousal ratings *Ms* = 1.29 and 1.24, respectively), $t(54) = -28.99$, $p < .001$ (patients), and $t(166) = -65.19$, $p < .001$ (controls). The emotional sentences used for patients and controls were also more negative (Pleasure ratings *Ms* = 1.70 and 1.75, respectively) than the neutral sentences (Pleasure ratings *Ms* = 5.02 and 5.00, respectively), $t(54) = 29.77$, $p < .001$ (patients), and $t(166) = 54.01$, $p < .001$ (controls).

C. Procedure

There were five main parts in the study: (a) neuropsychological assessment, (b) structural brain imaging, (c) self- and other-person knowledge testing, (d) SRE and ORE testing, and (e) emotion enhancement effect in memory. Informants were contacted by phone and mailed a packet that included: a set of the personality trait questionnaires for them to complete, a letter with instructions, and a self-addressed stamped envelope to return the questionnaires. Patients and controls completed all testing in the laboratory. They were assessed individually and participated in two or three sessions, approximately one to two hours long. During session one, they completed testing of the SRE, part of the neuropsychological assessment battery, and the first set of questionnaires to assess self- and other-person knowledge. During session two, patients and controls completed the rest of the neuropsychological tests, the second set of self- and other-person knowledge questionnaires, and testing of explicit memory enhancement after emotional processing. Those participants who agreed to also undergo brain imaging and who had no contraindications to having an MRI (n = 5), participated in a third session.

Neuropsychological Assessment. Participants provided general background and medical information. Patients recruited through the Amnesia and Cognition Unit had received a battery of neuropsychological tests including the WASI (Wechsler, 1999), the NAART (Spreen & Strauss, 1998), WMS-III (Wechsler, 1997) and tests contributing to frontal and memory factor scores. Tests contributing to frontal and memory factor scores are listed in Study 1. Patients recruited from the community completed the same neuropsychological test battery. Controls were administered the specific tests contributing to frontal and memory factor, and the NAART (Spreen & Strauss, 1998).

Each patient and control received a score representing relative performance on the group of tests comprising the frontal and memory factor. The composite scores for each individual represent average z scores for those tests loading on each factor, relative to the present group of participants (i.e., $n = 24$) . Table 10 shows mean group statistics on the NAART, and frontal and memory factor scores.. An independent samples t-test on these scores showed there were no significant group differences on NAART scores, t (22) = .18, $p = .85$, or frontal factor scores, t (22) = -1.46, $p = .16$, but patients had significantly lower memory performance than controls, t (22) = -5.89, $p < .001$. It is worth noting that there was great variability in patients' frontal factor scores.

Structural Brain Imaging. Structural brain images were acquired via a 1.5T General Electric Signa LX Excite scanner. All sequences were acquired using an MRI Devices 8 channel high resolution brain array (Wukesha, WI). T1-weighted whole brain images were collected with a 3D Inversion Recovery prepared Spoiled Gradient Echo (IRprep SPGR) sequence (124 sagital images; TE = 2.2 ms ; TR = 5.7 ms; TI = 450 ms; flip angle = 15 degrees; NEX = 2; BW = 62.5 kHz; FOV = 26cm; voxel size 1.02 X 1.02 X 1.5). T2-weighted and proton density images were acquired through T2 dual fast spin echo sequence (34 axial images; TE1 = 17ms [for proton density images]; TE2 = 120ms [for T2-weighted images]; TR = 4500ms; ETL = 8; FOV = 26cm; slice thickness = 4mm; NEX = 2; BW = 20.83 kHz; voxel size = 1.02 x 1.02 x 4.0mm).

Assessment of Self- and Other- Knowledge. Assessment of self- and other-knowledge was conducted in similar fashion to Studies 1 and 2, except that informants were mailed the personality trait questionnaires. Four of the eleven informants for patients did not know the patient premorbidly, and thus did not complete the questionnaire that asked them to rate patients premorbidly. Patients and controls were tested in the laboratory. In addition to their ratings of self- and other-knowledge, patients and controls were asked to rate how well they knew their informants, how close they were to them, and how much like them they were on a 5-point scale ranging from *hardly at all* to *very much*. They were also asked to report for how long they had known their informants (see Table 11). Informants were also asked to rate how well they knew the patients using a similar scale. All informants reported knowing patients either “pretty well” (rating = 4) or “very well” (rating = 5).

Table 11. Mean statistics (*SDs*) on relation to informant measures for patients and controls

Participants	Knowledge[a]	Closeness[a]	Likeness[a]	Length[b]
Patients	4.75 (.45)	3.83 (1.27)	2.92 (1.78)	23.54 (17.83)
Controls	4.75 (.45)	4.83 (.58)	3.25 (1.14)	23.75 (8.90)

Note. Closeness = how close participants were to informants; Knowledge = how well participants knew informant; Likeness = how much alike participants were to informants; Length = for how long participants had known informants.
[a] = rating on a 5-point scale ranging from 1 (*hardly at al)* to 5 (*very much)*
[b] = number of years

SRE and ORE. There were three main phases in our testing of the SRE: an intentional learning phase, an immediate cued-recall testing phase, and a delayed recognition testing phase. During the intentional learning phase, patients' and controls' task was to answer a question about each of the target verb-noun phrases, and to try to remember the phrases. Each list was learned under one of three orienting tasks: SR, OR, and structural encoding. In a SR condition participants answered the question, "Are you the type of person who would do this?" In the OR condition participants judged whether their informant would engage in the activities depicted in the verb-noun phrases by answering the question, "Is XXX the type of person who would do this?" Under the structural encoding condition participants were asked "Does this phrase have 4 syllables?"

Patients studied three separate lists of 16 phrases, each followed by an immediate cued-recall test. Controls studied one set of 48 phrases comprised of the three blocked target lists, each under one of the encoding conditions, followed by an immediate cued-recall test. Five minutes after the cued-recall memory test for the last list, patients undertook a yes-no recognition memory test. Thirty minutes after the immediate cued-recall testing, controls completed a yes-no recognition memory test.

Lists were counterbalanced such that, across subjects, phrases appeared equally often in each of three orienting tasks. In addition, phrase order was randomized within each list, and each participant received a different random order. The order of conditions was partially counterbalanced: The structural condition was always presented first, to establish a baseline, and the order of OR and SR tasks was counterbalanced. Each list also served as a target and distractor an equal number of times.

Participants were seated in front of a computer where the procedure was explained to them. They underwent two practice trials for each orienting task to get acquainted with all aspects of the experimental procedure. Each trial comprised the presentation on the computer screen of one of the questions defining the learning task (e.g. "Are you the type of person who would do this?") for 3 s (2 s for controls), after which a phrase (e.g. "ride a camel") also appeared for a duration of 7 s (5 s for controls). A blank screen was displayed for 1 s (.5s for controls) at the end of each trial.

After completing the learning phase, participants engaged in a distractor task (i.e., number cancellation task) for two minutes and then began the cued-recall test. In the cued-recall test, verbs were presented in a booklet, one verb on each page, and participants were asked to complete each verb with the rest of the phrase as it appeared previously on the computer screen. For patients, each cued-recall test consisted of a booklet with the 16 target verbs in a fixed but different random order than the one presented during learning. Controls received a single cued-recall test consisting of the 48 target verbs blocked by orienting task. The blocks were presented in the same order as encoding, while verbs within each block were in a fixed but different random order than the one at encoding. Patients were given 4 minutes to complete each of the cued-recall tests, and controls were given 5 minutes to complete the one cued recall test. If participants had gone through the booklet once and there was still time remaining they were asked to go over the booklet again and try to complete the remaining phrases until the allotted time had lapsed.

After a five min (patients) or 30 min (controls) delay, participants were presented with the yes-no recognition memory test. In order to prevent rehearsal during the delay, participants were administered visuospatial and executive function tests. Ninety-six verb-noun phrases were presented sequentially in the center of a computer screen: half of them were new phrases (with a new noun paired with a studied verb) and half were the ones comprising the target lists. Participants were asked to indicate whether each phrase was old or new. Each phrase remained on the screen until the participant pressed one of two keys to indicate if he or she recognized the phrase as one that had been previously presented.

Response reaction time (RT) was measured in milliseconds from item-on-screen to key press during encoding and recognition memory tasks. All responses and response RTs during learning and recognition memory were recorded on the computer.

<u>Emotion Enhancement Effect in Memory.</u> There were three phases in our testing of the emotion enhancement effect in memory: intentional learning, immediate yes-no

recognition test, and rating phase. During the intentional learning phase patients and controls were asked to indicate whether each sentence was emotional by pressing the appropriate key on the computer keyboard. In addition, they were told to try to remember the sentences. Sentence order was randomized within each list, and each participant received a different random order. Stimuli were presented on a computer screen. Participants underwent two practice trials to get acquainted with the experimental procedure. Each trial comprised the presentation on the computer screen of the question "Is this sentence emotional?" for 3 s (2 s for controls), after which a sentence (e.g. "They hung the drawing in the living room", "Ten thousand people died when the concert was bombed") also appeared for a duration of 7s (5 s for controls).

After completing the learning phase, participants engaged in a distractor task (i.e., counting backwards by sevens and threes from 100) for two minutes and then started the yes-no recognition test. Fifty-six sentences were presented to patients (168 to controls) sequentially in the center of a computer screen: half of them were new sentences, and half were the ones comprising the target list, randomly mixed. Participants were asked to indicate whether each sentence was old or new. Each sentence remained on the screen until the participant pressed one of two keys to indicate if he or she recognized the sentence as one that had been previously presented.

Response reaction time (RT) was measured in milliseconds from item-on-screen to key press during encoding and retrieval tasks. All responses and response RTs during learning and test were recorded on the computer.

After the end of the recognition test all 56 (168 for controls) target and distractor sentences were rated by participants for arousal (emotional intensity) and valence (degree of pleasant, neutral or unpleasant affect), using the self-assessment mannequin (SAM) rating system (Hodges, Cook, & Lang, 1985; Lang, 1980; see Figure 2). Arousal and valence were assessed using five mannequin figures. For the arousal dimension, the appearance of the figures ranged from *having an inactive body and closed eyes* to *having an active body and eyes wide open* (see Figure 2). In the case of the valence dimension, the appearance of the SAM figures ranged from *smiling with raised eyebrows* to *frowning with knitted eyebrows* (see Figure 2). A 9-point scale was displayed below the figures. Participants recorded their ratings by pressing the key on the keyboard that corresponded to their experience of emotion. The figures and rating scale were presented at the bottom of the computer screen, and the sentences were presented sequentially and in random order at the top of the screen. Participants first rated all sentences for arousal, and then for valence.

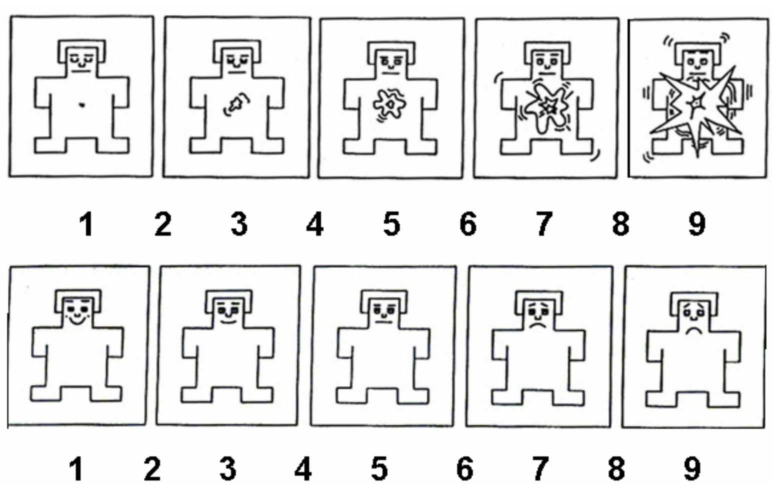


Figure 2. Self-Assessment Mannequin Rating System

IV. Results

A. Self- and Other-Person Knowledge

Consistency and accuracy of self and other-person knowledge were computed in similar fashion as in Study 1 and 2. Mean values and standard deviations on these measures for patients and controls can be found in Table 12. Independent sample t-tests showed that as a group patients were less congruent with informants in rating themselves than controls, $t(19) = -2.74$, $p < .05$, but there were no significant group differences on any other of the person-knowledge measures.

Table 12. Self- and other-person knowledge measures for memory-impaired patients and controls.

Participants	Self-Knowledge		Other-Person Knowledge	
	Consistency[a]	Accuracy[b]	Consistency[c]	Accuracy[d]
Patients	.70 (.11)[e]	.50 (.18)[f]	.75 (.22)[e]	.59 (.27)[f]
Controls	.80 (.12)[e]	.67 (.09)[g]	.79 (.16)[e]	.67 (.19)[g]

Note. *M* (*SD*)
[a] *ICC(1)* between participants' self-ratings at two points in time
[b] *ICC(A,1)* between participants' self-ratings and informants' ratings of participants
[c] *ICC(1)* between participants' other-person ratings at two points in time
[d] *ICC(A,1)* between participants' other-person rating and informants' self-ratings
[e] n = 12
[f] n = 11
[g] n = 10

Table 13 shows individual patient data on self- and other-person knowledge measures. Individual patient's performance that was below two *SDs* from the mean of controls was considered abnormal. Similar to findings of our previous study in brain-damaged patients (Marquine & Glisky, 2005), there was great variability in patients' accuracy of self-knowledge. Eight of the 11 patients who contributed data to the accuracy of self-knowledge measures performed more than 2 *SDs* below controls on this measure (i.e., patients shown on rows one through seven on Table 13). Three of them (shown on first three rows of Table 13) also showed impaired knowledge of their informant, even though two of them had met their informant pre-morbidly (i.e., PAT023 and PAT056). The remaining five patients who showed inaccurate self-knowledge (i.e. PAT011, PAT027, PAT012, PAT045, and PAT014) did not necessarily change personality or rate themselves as they used to be. The only aspect of patients' performance that appeared consistent across patients was that those patients who were congruent with informants in rating themselves (i.e. PAT016, PAT029, and PAT054) were also congruent in rating their informants. Also note that all three patients met their informants after the incident that resulted in memory impairment.

Given that time since injury had been shown in our previous study with brain-damaged patients to be related to consistency of self-knowledge measures (Marquine & Glisky, 2005), we computed Pearson product-moment correlations for our patient group between self-measures and time since injury. Neither accuracy nor consistency of self-knowledge was significantly correlated with time since injury in the present study (r = -.09 and r = -.42, respectively). Time since injury ranged from three to 27 years (M = 15, SD = 7 years post injury). Three of the five patients who showed an inconsistent sense of self in our prior study three years ago, also participated in the current one. All of them showed higher consistencies of self-knowledge this time, with the highest improvement being for a patient who was a little over a year post-injury the first time she participated. Her consistency measures went from *ICC(1)* = .27 to *ICC(1)* = .77.

We also computed Pearson product-moment correlations on all participants between self- and other-knowledge measures, and frontal and memory factor scores. Frontal factor scores were significantly correlated with consistency and accuracy of self-knowledge ($r = .57$, $p < .01$, and $r = .46$, $p < .05$, respectively) and consistency and accuracy of other-knowledge ($r = .68$, $p < .01$, and $r = .46$, $p < .05$, respectively) . None of the correlations with memory scores were significant (*rs* = .23 to .43).

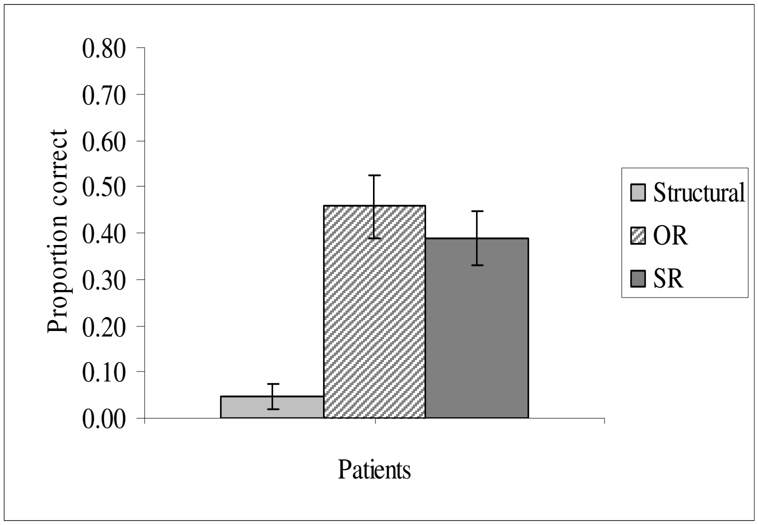
Table 13. Individual data on self- and other-person knowledge measures for patients with acquired brain damage

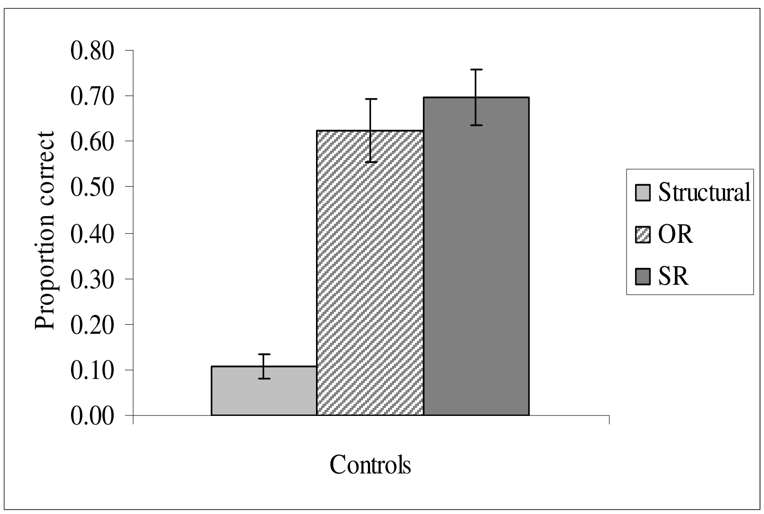
Participants	Self-Knowledge			Other-Person Knowledge		Personality Change[a]
	Consistency[b]	Accuracy[c]	Premorbid[d]	Consistency[e]	Accuracy[f]	
PAT023	.64	.21	.51	.55	.24	.31
PAT056	.51	.36	.13	.17	.12	-.02
PAT004	.70	.51	--	.86	.26	--
PAT011	.67	.51	.29	.85	.84	.39
PAT027	.77	.45	.49	.90	.51	.75
PAT012	.66	.48	-.29	.89	.75	-.23
PAT045	.72	.43	.72	.77	.69	.54
PAT014	.62	.47	.43	.81	.57	.72
PAT054	.86	.68	--	.91	.70	--
PAT029	.84	.79	--	.76	.81	--
PAT016	.85	.77	--	.98	.95	--
PAT015	.59	--	--	.57	--	--

Note. *M* (*SD*)
[a] *ICC(1)* between ratings of patient by informant pre- and post-morbidly
[b] *ICC(1)* between patient's self-ratings at two points in time
[c] *ICC(A,1)* between patient's self-ratings and informant's ratings of patient currently
[d] *ICC(A,1)* between patient's self-ratings and informant's ratings of patient before the onset of memory problems
[e] *ICC(1)* between patient's other-person ratings at two points in time
[f] *ICC(A,1)* between patient's other-person ratings and informant's self-ratings

B. SRE and ORE

Cued-Recall Performance. Figures 3a and 3b show the mean proportion and standard errors of correct recalls for patients and controls, respectively. The absolute levels of performance of patients and controls are not comparable given that list length was different for the two groups. A repeated measures (Encoding task: structural, OR, and SR) ANOVA on correct recall scores for patients revealed a significant effect, $F(2, 22) = 33.86$, $p < .001$, $\eta_p^2 = .76$. Subsequent pairwise comparisons indicated that SR and OR resulted in higher levels of memory performance than structural encoding (*ps* <.001), but performance on OR and SR task did not differ significantly ($p = .16$). A repeated measures ANOVA on correct recall scores for controls also showed a significant effect of task, $F(2, 22) = 71.64$, $p < .001$, $\eta_p^2 = .87$. Subsequent pairwise comparisons showed that controls also benefited from OR and SR encoding as compared to structural encoding (*ps* <.001), and did not benefit differentially from OR or SR encoding ($p = .22$). These results indicate that both patients and controls benefited from OR and SR processing, but these two types of processing were equally beneficial for recall performance.





Figures 3a and 3b. Mean proportion of correct cued-recall and *SE* as a function of learning task (structural, other-reference [OR] and self-reference [SR]) for patients (*n* = 12) and controls (*n* = 12).

Note. Performance levels in patients and controls are not directly comparable given that list length was different for these groups. Thus, data for patients and controls are presented in separate graphs.

In order to explore whether improvement in memory performance in the SR condition was evident for both endorsed and non-endorsed items, we compared the proportion of items that were answered affirmatively to those that were answered negatively during learning across the three conditions. Words that were not given a response during learning were not included in this analysis. Table 14 shows the mean proportion of correct recalls as a function of whether a word received a yes or no response during encoding. A 3 (encoding task) X 2 (encoding response: yes or no) ANOVA on these values for the patient group showed a lone significant main effect of encoding task, $F(2, 22) = 30.84$, $p < .001$, $\eta_p^2 = .74$. A similar analysis for controls showed the same pattern of results, i.e. only a significant main effect of encoding task, $F(2, 22) = 63.29$, $p < .001$, $\eta_p^2 = .85$. These findings indicate that overall, yes responses were not remembered better than no responses, as reported in most previous studies on the SRE (Symons and Johnson, 1997), and that the SRE and ORE were not affected by the type of encoding response (i.e. yes or no).

Table 14. Mean Proportions (*SDs*) of Correct Recalls as a Function of Study Response

	Response by Encoding Task					
	Structural		OR		SR	
Group	Yes	No	Yes	No	Yes	No
Patients	.01 (.04)	.07 (.12)	.39 (.22)	.47 (.25)	.39 (.25)	.35 (.28)
Controls	.10 (.09)	.09 (.12)	.59 (.17)	.67 (.29)	.67 (.20)	.65 (.26)

Recognition Performance. Table 15 shows the mean proportions and standard deviations of hits, false alarms and corrected recognition scores (hits minus false alarms), for both patients and controls. Two separate repeated measures (Encoding task: structural, OR, and SR) ANOVAs on corrected recognition scores for the patient and control group, revealed a significant effect of encoding task (patient group: $F[2, 22] = 25.80, p < .001$ [$\eta_p^2 = .70$]; control group: $F[2, 22] = 54.67, p < .001$ [$\eta_p^2 = .83$]). Subsequent least squares pairwise comparisons confirmed the pattern obtained in recall for both groups of participants: SR and OR encoding led to significantly better recognition than structural encoding (*ps* < .001), but did not differ form each other (patients: p =.26; controls: p = .61). It is also worth noting that all participants showed a SRE and only one patient did not show an ORE.

Table 15. Mean Proportions (*SDs*) of Hits, False Alarms, and Corrected Recognition Scores (Hits minus False Alarms) across Encoding Task for Patients and Controls

	Encoding Task		
Group	Structural	OR	SR
Patients			
Hits	.42 (.30)	.85 (.19)	.87 (.16)
False Alarms	.21 (.19)	.18 (.21)	.13 (.16)
Corrected Recognition	.22 (.22)	.67 (.29)	.73 (.28)
Controls			
Hits	.59 (.28)	.97 (.05)	.97 (.07)
False Alarms	.22 (.14)	.06 (.09)	.05 (.05)
Corrected Recognition	.38 (.23)	.91 (.12)	.92 (.08)

As shown in Table 15, the performance of controls for hits on the OR and SR tasks was on the ceiling. Hence, participants' performance on hits will not be considered further. A repeated measures ANOVA on proportion of false alarms by encoding task for the patient group was not significant, $F(2, 22) = 2.08$, $p = .15$. A similar ANOVA for the control group, revealed a significant main effect of task, $F(2, 22) = 9.23$, $p < .01$, $\eta_p^2 = .46$. Subsequent pairwise comparisons indicated that controls made significantly fewer false alarms in the SR and OR task compared to structural encoding (*ps* <.05), but false alarm rates in the SR and OR tasks did not differ from each other ($p = .56$).

C. Emotion Enhancement Effect in Memory

Recognition Performance. Table 16 presents the mean proportion of correct recognition scores (hits minus false alarms), hits and false alarms across type of stimuli (neutral and emotional) for the patient and control groups. Given that list length was different for patients and controls, results were analyzed separately for each group. To explore the effect of emotion on memory, paired sample t-tests were performed on corrected recognition scores for the patient and control groups by type of stimuli (i.e. emotional vs. neutral sentences). Results of these analyses showed that emotional sentences were recognized significantly better by both patients and controls than neutral sentences (patients: t (11) = -2.65, p <.05; controls: $t(11) = -5.70$, p <.01). Analyses on proportion of hits yielded similar results (all *ps* <.05). In contrast, there were no significant differences in rates of false alarms for either group (*ps* ≥.80). Hence, patients and controls both showed an emotion enhancement effect in memory.

Table 16. Mean Proportions (*SDs*) of Hits, False Alarms, and Corrected Recognition (Hits minus False Alarms) by Stimulus Type (Neutral and Emotional) for Patients and Controls

	Stimulus Type	
Group	Neutral	Emotional
Patients		
Hits	.55 (.30)	.74 (.21)
False Alarms	.14 (.18)	.13 (.17)
Corrected Recognition	.41 (.33)	.61 (.23)
Controls		
Hits	.79 (.15)	.95 (.05)
False Alarms	.10 (.09)	.10 (.09)
Corrected Recognition	.69 (.14)	.85 (.10)

Given that the effect of emotion on explicit memory has not been investigated in patients with memory impairment after TBI, we explored the performance of our subgroup of patients with TBI, and contrasted it to the performance of a subgroup of our normal controls matched in age and years of education to patients. The pattern of performance of this subgroup of patients and controls did not differ from that of the entire group of participants, and indicated an emotion enhancement effect on explicit memory in our group of TBI patients. See Appendix for mean proportion (SDs) of hits and false alarms for patients and controls.

Arousal and Valence Ratings. Table 17 shows the mean arousal and valence ratings by patients with acquired brain damage and controls of the 28 neutral and the 28 emotional sentences shared by both groups. Independent samples t-tests comparing patients and controls on arousal and valence ratings of emotional and neutral sentences revealed no significant differences ($ps \geq .09$). This suggests that the experience of emotion by patients and controls, at least as measured through ratings of their experience, did not differ significantly.

Table 17. Mean (*SDs*) Arousal and Valence Ratings for Emotional and Neutral Sentences by Patients and Controls

Participants	Arousal Ratings		Valence Ratings	
	Neutral Sentences	Emotional Sentences	Neutral Sentences	Emotional Sentences
Patients	1.17 (.24)	6.49 (1.9)	3.61 (1.17)	8.11 (.59)
Controls	1.39 (.43)	6.71 (1.06)	4.29 (.58)	7.67 (.63)

Relation to Cognitive Performance. To calculate the effect of emotion on explicit memory, we subtracted corrected recognition scores for emotional sentences from scores for neutral sentences. To test whether showing an effect of emotion in memory was dependent upon memory and frontal function, we computed Pearson product-moment correlations between the degree of memory enhancement as a result of emotion and frontal and memory factor scores on all participants. Neither of these correlations were significant, $r = -.22$, and $r = -.23$. Visual inspection of the data indicated no difference in pattern of performance between patients and controls.

D. Relation between person-knowledge and effect of SR and OR processing in memory

To obtain independent measures of the OR and SR effects, each was calculated relative to the structural encoding baseline by subtracting the cued-recall and corrected recognition score in the structural condition from each of the other scores. This allowed us to calculate independently the relation between ORE and SRE and our other variables.

To explore the relationship between the enhanced memory effects associated with SR and OR processing, and degree of self-and other-knowledge, Pearson product-moment correlation coefficients were computed between the SRE and ORE, and consistency and accuracy measures of self-and other-knowledge on all participants (see Table 18). Given the large number of intercorrelations, *p* values were set at .01. The size of the SRE in cued-recall was significantly correlated with accuracy of self-knowledge (r = .70), and the size of the ORE in cued-recall was significantly related to accuracy of other-knowledge(r = .58). Figures 4a and 4b depict the relation between these variables.

Table 18. Intercorrelations among SR and OR Effects in Cued-Recall and Person-Knowledge Measures

	1	2	3	4	5	6
1. SRE	--	.63**	.70**	.36	.44*	.28
2. ORE		--	.51*	.58**	.38	.45*
3. Accuracy SK			--	.62**	.75**	.53*
4. Accuracy OK				--	.47*	.72**
5. Consistency SK					--	.68**
6. Consistency OK						--

Note. OK = other-knowledge; ORE = other-reference effect; SK = self-knowledge; SRE = self-reference effect.
*p <.05, two-tailed. **p <.01, two-tailed.

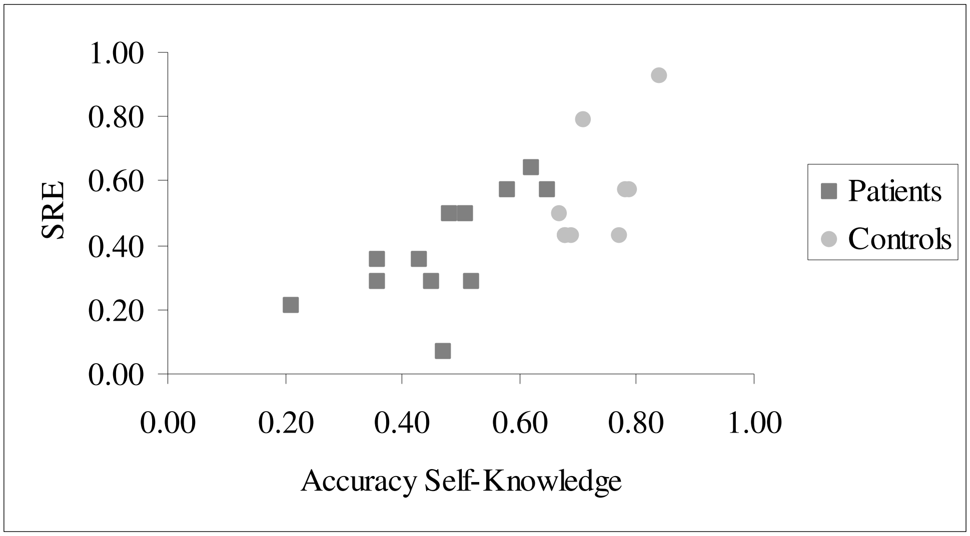


Figure 4a. Relation between accuracy of self-knowledge and the SRE in cued-recall.

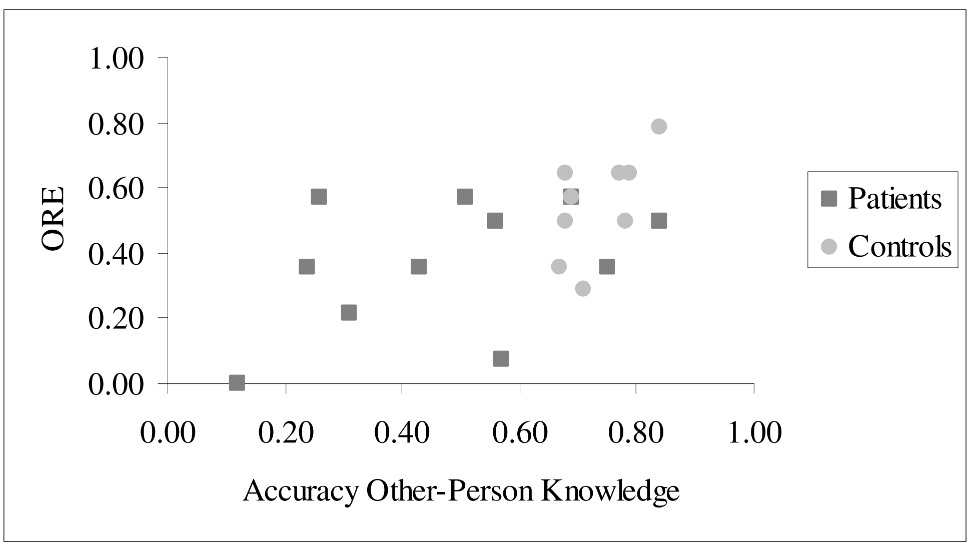


Figure 4b. Relation between accuracy of other-person knowledge and the ORE in cued-recall.

E. Relation between the Effect of Emotion in Memory and the SRE

To explore the feasibility of an emotional explanation of the SRE, we computed Pearson product-moment correlation coefficients on all participants between the SRE and ORE processing in recognition memory and cued-recall testing, and emotional memory enhancement. None of these correlations was significant (*rs* = -.21 to .17). However, upon visual inspection of the data it appeared to be the case that patients might show a relation between their ability to benefit from SR processing and emotion in recognition memory (*r* = .30) that is not evident in controls (*r* = -.18; see Figure 5a). In contrast, degree of ORE in recognition did not seem to be related to the size of the emotion enhancement effect in memory in patients or controls, *r* = .12 and *r* = -.28, respectively (Figure 5b). Given the relatively restricted range of the emotion enhancement effect in the control group, we cannot interpret results in this group. Results from the patient group suggest that emotion may play a role in SR processing.

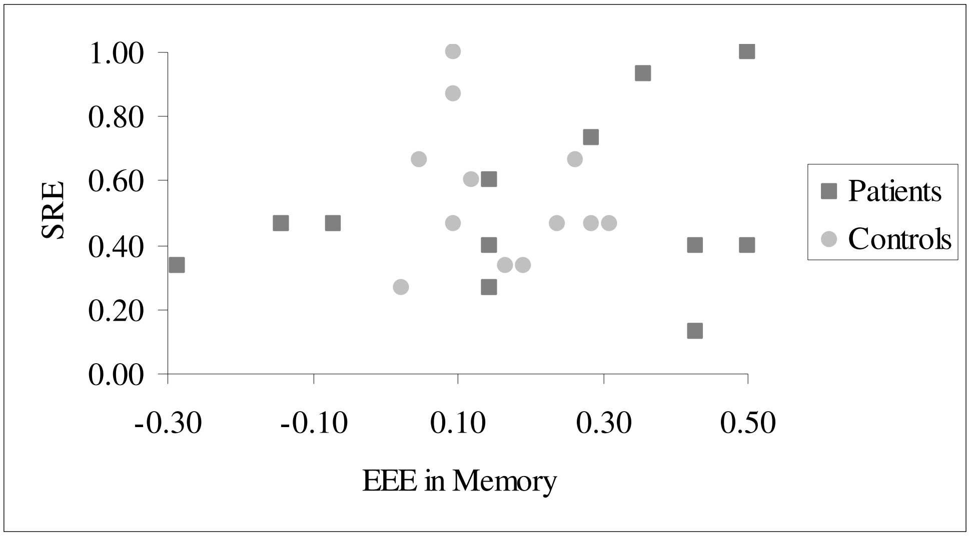


Figure 5a. Relation between emotion enhancement effect in memory and the SRE in recognition memory

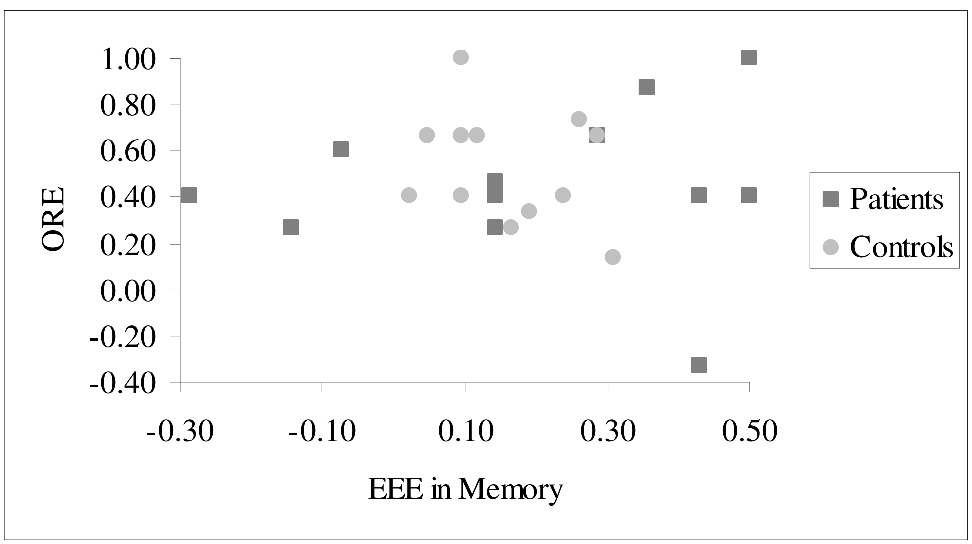


Figure 5b. Relation between emotion enhancement effect in memory and the ORE in recognition memory

F. Relation between SRE and ORE, and Cognitive Function

To explore the relation between SRE and ORE and cognitive function, scatterplots were constructed with the frontal and memory factors represented on one axis and the SRE and ORE on the other. Visual inspection of the data suggested that frontal factor scores were related to SRE and ORE in the patient group, but not in the control group (see Figures 6a and 6b). Pearson product-moment correlation coefficients were computed between recognition and cued-recall performance on SRE and ORE, and frontal factor scores for the patients and control group separately. For patients, frontal function was significantly correlated with recognition measures of SRE, $r = .77$, $p < .01$, and ORE, $r = .61$, $p < .05$ (see Figures 6a and 6b), while the correlations with cued recall measures of the SRE and ORE were marginally significant ($r = .57$, $p = .06$, for both measures). For controls, none of the correlations were significant.

The relation between memory function and OR and SR effects did not seem to be different for patients and controls. Pearson product-moment correlation coefficients computed for the entire group of participants ($n = 24$) between these measures, showed that memory function was significantly correlated with cued recall measures of the SRE ($r = .76$, $p < .01$) and ORE ($r = .41$, $p < .05$), but not with recognition memory measures.

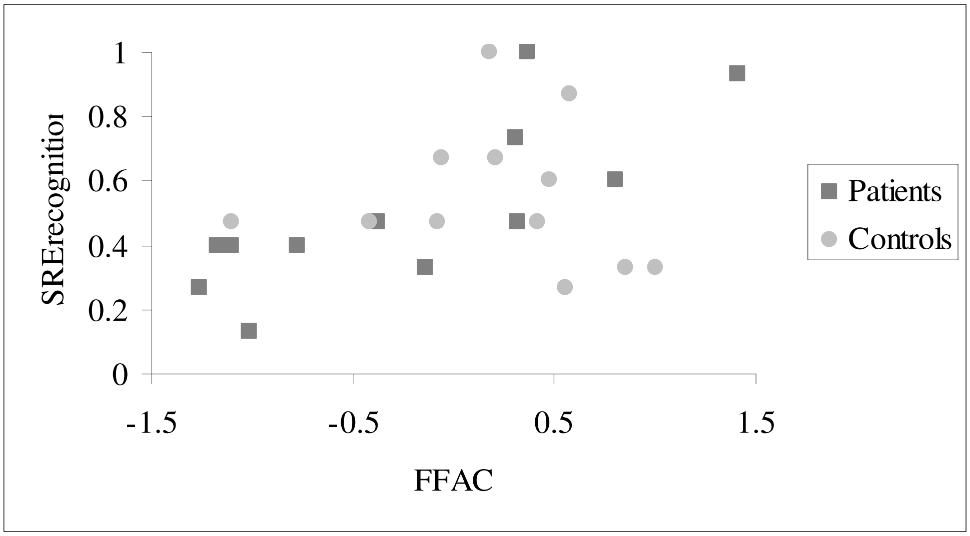


Figure 6a. Relation between frontal factor (FFAC) scores and the SRE in recognition memory

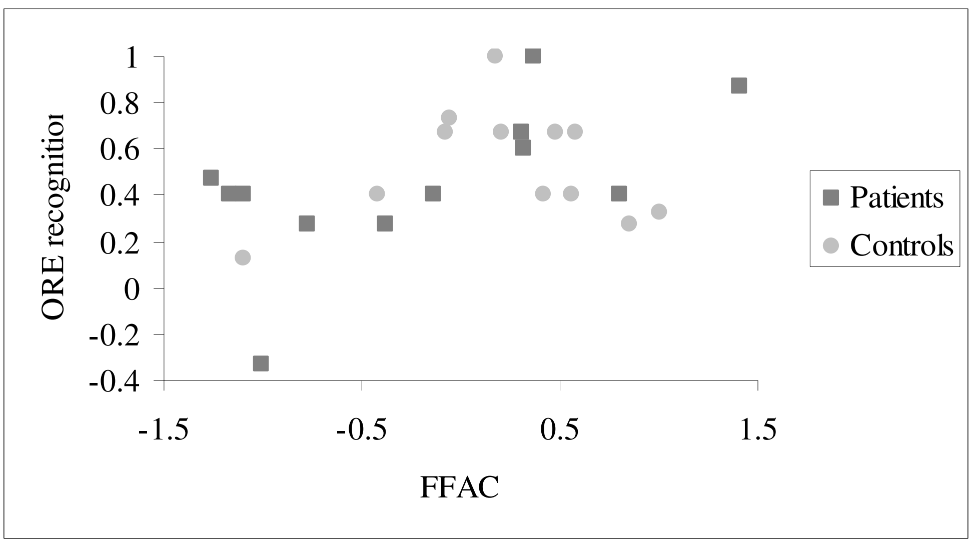


Figure 6b. Relation between frontal factor (FFAC) scores and the ORE in recognition memory

G. Relation between ORE and Measures describing the Relationship with Informants

Table 11 shows mean statistics for patients and controls regarding their ratings of how well they knew their informants, how close they were to them, how much like them they were and for how long they had known them. Independent sample t-tests showed that patients reported being significantly less close to informants than controls did, t 22) = -2.49, p <.05. No other variables differed significantly between groups (*ps* ≥ .59). In order to explore the relation between these variables and the enhanced memory effects associated with OR processing, Pearson product-moment correlation coefficients were computed between these variables and the ORE in cued-recall and recognition testing. None of these correlations were significant. However, there was a substantial restriction of range on the extent that participants reported knowing their informants, with ratings ranging from 4 (*pretty well*) to 5 (*very well*). Thus, the lack of correlation with this measure is not interpretable.

VI. Discussion

A. Self-knowledge and Other-Person Knowledge in Acquired Brain Damage

The present study found that, comparable to previous published findings (Klein, Loftus, et al. 1996; Klein, et al., 1999), patients with memory impairment as a result of acquired brain damage, were as consistent as controls in rating themselves across two occasions, suggesting that they had a relatively stable sense of self. However, these findings are in contrast to results from our previous study with a group of memory-impaired patients with acquired brain damage (Marquine & Glisky, 2005), where some patients did not show a consistent sense of self. One important difference between these two studies was that the patients who showed the most prominent frontal/executive deficits in our prior study did not participate in the current one.

Both in our prior study with brain-damaged patients and the current one, we found a significant correlation between frontal functioning and consistency of self-ratings. However, results from the present study found that other-person knowledge was also correlated with frontal functioning. On the one hand, these findings may be interpreted as evidence in support of the hypothesis that frontal structures are important in mediating person information. On the other hand, it may simply be the case that frontal/executive performance is related to consistency in overall performance, regardless of the task at hand.

The fact that almost all patients showed highly consistent sense of selves in the current study, along with the fact that the closest a patient was post-injury was three years, may explain why we did not find a correlation between consistency of the self-representation and time since injury, as had been the case in our prior experiment (Marquine & Glisky, 2005). Further, all patients who had shown an inconsistent sense of self in our prior study and that also participated in the current one, showed an improvement in consistency of their self-representation. The most striking difference was exhibited by a patient whose injury had occurred a little over a year post injury the first time she participated. Unfortunately, she did not complete other-person knowledge measures at that time and so we do not have a control task to examine test-retest effects. Based on these findings, the potential effect of time since injury on self-knowledge after acquired brain damage cannot be discounted at this time. Future studies exploring the relation between time since injury and self-representation, could test patients closer to the time of insult, and either follow them longitudinally or compare their performance with that of patients a few years post injury. Given that recovery of function after brain injury occurs mostly within the first one and a half year post-injury, it would be crucial to also use other-person knowledge or other comparison tasks.

Accuracy of self-knowledge, as measured by correlations between patients and informants ratings, was high for some patients, as found in previous studies (Klein, Loftus, et al. 1996; Klein, et al, 1999), but low for others. We also observed this variability in performance in our previous study (Marquine & Glisky, 2005). In the current study we asked patients to also rate another person they knew well in order to have a comparison condition for self-knowledge measures, which would aid in interpreting variability in self measures. Given our findings that patients were less accurate than controls in rating themselves, but as good as controls in rating their informants, it may be argued that the inaccuracies observed in patients were specific to self-ratings. However, if we look at patient's individual performance, this does not appear to be the case. A subset of the patients who showed inaccurate self-knowledge also showed inaccurate knowledge of their informant, while others showed inaccurate self-knowledge but accurate other-person knowledge. In contrast to findings from our previous study with AD patients, patients with acquired brain damage who rated themselves accurately did not tend to rate themselves as they used to be. However, a clear pattern of performance did not emerge, and thus it is difficult to interpret the inaccuracies of self-ratings in some patients. The one thing that appeared to be consistent across patients was that those who were consistent in rating themselves were also consistent in rating their well-known other. Moreover, both accuracy measures were significantly correlated with our measures of frontal functioning. These latter two findings suggest a lack of dissociation between self-and other-person knowledge in these patients with acquired brain injuries.

Accuracy of self-knowledge may be interpreted as the extent to which self-knowledge has been updated in patients. Therefore, low self-accuracy may indicate a deficit in patients' ability to update their sense of self. This interpretation is based on the assumption that the informant's perception of the patient is accurate. Although in our study patients and their informants reported knowing each other pretty well to very well there is no way for us to know who is "accurate", the patient or the informant. An injury to the brain may not only affect the patient, but also his or her relationships, and the way that he or she is perceived by others. Any of these factors alone, or in combination, could affect the extent to which the patients' and the informants' ratings of the patient are congruent.

Another finding of interest concerns other-person knowledge measures. As a group, patients did not differ from controls on consistency or accuracy of other-person knowledge. As noted above, however, three patients showed inaccurate other-knowledge, and one of these patients also showed inconsistent other-knowledge. Perhaps more interesting was the finding that three of the four patients who had met their informants post-morbidly, showed accurate other-person knowledge. The one who did not, also showed inaccurate self-knowledge. These findings suggest that at least some memory-impaired patients can learn new semantic information about another person, which is consistent with results from our case study on the confabulatory patient. None of the studies previously reported in the literature with amnesic patients with stable memory impairment had investigated whether this was the case, since informants were individuals that the patients had known premorbidly. The one case study with a patient with AD (Klein at al., 2003) suggested that she was unable to acquire new other-person information.

B. The SRE and ORE in Memory-Impaired Individuals

The present study replicated a previous finding (Marquine & Glisky, 2005) that patients with memory impairment exhibit a SRE in memory, and extended this prior experiment in several ways. First, the current study used cued-recall and recognition testing instead of recognition only, and used short verb-noun phrases as stimuli instead of trait adjectives, showing that the effect is robust across testing formats and type of stimuli in patients with memory deficits as a result of acquired brain damage as in normal controls. This is a critical step in the development of memory rehabilitation methods based on this effect. Second, we showed that processing with respect to a well-known other also improved memory to similar levels as SR processing in our group of memory-impaired patients and in normal controls. This is consistent with findings from previous studies on normal adults (Symons & Johnson, 1997). Because list length was different for patients and controls, only the pattern of performance of these two groups can be contrasted in our study, not absolute levels of performance. Nevertheless, our findings suggest that a significant SRE and ORE can be obtained in patients despite very poor episodic memories.

Previous studies in normal individuals (e.g. Kuiper & Rogers, 1979; Rogers et al., 1977) and memory-impaired patients (Marquine & Glisky, 2005) have shown that participants tend to remember information that is endorsed as self-referential better than information that is not so endorsed, but that the SRE is evident both for items endorsed as self-referential and items that are not endorsed as self-referential. In contrast, we found neither the SRE or ORE were affected by the type of encoding response (i.e. "yes" or "no") in either of our groups when using cued-recall testing. Because controls' performance on recognition hits was on the ceiling, we did not explore whether this was also the case in recognition memory testing. Thus, our findings may be the result of testing format or type of stimuli used (i.e. verb-noun phrases depicting activities in which people do not usually engage in). Regardless of what variable accounts for this pattern of performance, it did not seem to affect the SRE and ORE, or patients and controls, differentially.

To sum up, results indicate that performance on an episodic memory task was improved in memory-impaired individuals by processing information in relation to the self or a well known other, similar to normal individuals. Moreover, these SR and OR effects are evident both for information that applies to themselves or their well-known other, and for information that does not apply. Based on these findings it seems likely that a possible strategy for memory rehabilitation may be to encourage patients to process new information in relation to the self or a well-known other.

C. Effect of Emotion on Explicit Memory in Memory-Impaired Individuals

Consistent with findings from a small number of studies on amnesic patients (Burton, et al., 2004, Frank & Tomaz, 2003, Hamman, Cahill, McGaugh, & Squire, 1997; Hamman, Cahill, & Squire, 1997, Phelps, et al., 1997), we found an emotion enhancement effect on explicit memory in our group of patients with memory impairment. Although level of performance in patients is not comparable to that of controls in our study, it appears to be the case that our group of memory-impaired patients can improve their performance in an episodic memory task as a result of emotion. This was also true for our subgroup of patients whose memory-impairment was a result of sustaining a TBI, and represents an addition to the current literature. To the best of our knowledge, no studies have been published exploring the effects of emotion on memory in this population.

The extent to which memory was enhanced as a result of emotion was not related to frontal or memory function. Thus, emotional processing may provide a particularly useful way for individuals with poor memory and frontal functioning to improve their memories.

D. Mechanisms Underlying the SR and OR Effects

One of the purposes of the present study was to begin investigating some of the potential mechanisms underlying the SRE. Consistent with a cognitive explanation of the SRE, and one of our hypotheses, accuracy of self-knowledge was significantly correlated with the SRE, and accuracy of other-knowledge was significantly correlated with the ORE.

We had expected that if an emotional explanation of the SRE was feasible, the degree of the SRE would be related to the degree of the effect of emotion on memory. This appeared to be the case in our group of memory-impaired patients, although the correlation between these variables did not reach significance. It is interesting, however, that there was clearly no relation between the ORE and the emotion enhancement effect in memory.

These findings are consistent with the idea that the advantage provided by access to self-representation is partly affected by the same variables that affect other-processing. One of these variables may be related to the degree of organization and elaboration of the corresponding schematic representation of self and other- knowledge. Additionally, the effect of SR processing on memory may have a unique mechanism, which could be related to emotional processing. It may be the case that SR processing stirs emotional responses, or that both emotion and SR processing have a common mechanism by which they impact memory. The present study does not speak to this issue, but it does highlight the potential for both cognitive and emotional factors to contribute to explanations of the SRE in memory.

Both the SR and OR effects were related to frontal function in our patient group. This is in line with imaging findings showing frontal involvement in processing person information, and with the hypothesis that the SRE and ORE have at least one common underlying mechanism. The ability to benefit from SR and OR processing also seems to be dependent on basic memory function, at least when tested in cued-recall. This may reflect reduced consolidation or binding problems in individuals with poor memories.

These findings may place some boundary conditions on SR and OR benefits. However, it is also worth noting that all patients showed a SRE and only one did not show an ORE.

GENERAL DISCUSSION

I. Self-Knowledge in Memory Disorders

The present series of studies showed that different memory disorders might affect an individual's sense of self in varied manners. Further, our findings are consistent with the idea that at least some individuals with impaired episodic memory can have intact trait-self knowledge, which is thought to be represented in memory in abstract form and be dependent on a semantic memory system. In Study 1, a patient exhibiting a confabulatory syndrome as a result of ACoA ruptured aneurysm (J.S.) showed an impaired sense of self, which may be described as fleeting at best. J.S. showed profound memory and frontal deficits on neuropsychological exam, and damage to bilateral basal forebrain and VMPFC, as well as right frontopolar and frontal dorsolateral brain areas on structural neuroimaging. His performance was contrasted to that of another patient with similar memory impairments, but intact frontal function. This patient showed preserved knowledge of self. In Study 2, a group of patients in the early stages of AD showed a relatively stable sense of self compared to MCI patients, but only a few exhibited updated knowledge of self. The small number of patients who showed accurate knowledge of their current self, had not experienced a change in personality, as reported by their informants. Most AD patients had changed personality, but continued to rate themselves as they were premorbidly and seemed unable to update their self-knowledge. Self measures were related to frontal function, and accuracy of self knowledge was best explained by frontal and overall cognitive functioning. In Study 3, a group of patients with memory impairment as a result of acquired brain damage showed consistent knowledge of self, but varying degrees of self-accuracy. Further, all person-knowledge measures were related to frontal function, but not memory function.

Results of these patient studies add further support to imaging findings showing that the MPFC is involved in the processing of trait self-knowledge (Craik et al., 1999, Heatherton et al., 2006; Johnson et al., 2002; Kelley et al., 2002; Ochsner et al., 2005; Schmitz et al., 2004). Further, they suggest that not only are frontal brain areas implicated in this type of processing, but that they are necessary for an adequate sense of self. Another variable that may be important in supporting self-knowledge is the stability of cognitive impairments over time. Although results are not conclusive in this regard, they are consistent with the idea that when an individual's episodic memory system is flawed, exhibiting constant behavior over time may be critical for that individual to acquire new semantic information about self. For, acquisition of semantic knowledge in the face of episodic memory impairment requires repetition of the information to be learned.

II. Other-Person Knowledge in Memory Disorders

To the best of our knowledge, acquisition of knowledge about another person's personality in patients with memory disorders has been explored only in one published case study (Klein et al., 2003). This study found that an AD patient was unable to acquire trait knowledge about her caregiver. All of our AD patients had known their informants premorbidly, so our results with this group do not speak to this issue. However, our confabulatory patient (JS) and three of the four individuals in our group of patients with acquired brain damage who had met their informant postmorbidly, were able to rate their informants consistently and accurately. These findings suggest that at least some individuals with relatively stable cognitive impairments can acquire new information about another person.

III. Dissociation between Self- and Other-Knowledge

Studies 2 and 3 did not show clear evidence in support of the view that the self is special relative to knowledge about another person. For the most part, our group of AD patients showed impaired new self-knowledge, but preserved premorbid knowledge of self and of another person. Further, there was not a clear pattern of performance in our brain-damaged patients with inaccurate self-knowledge, but all patients with accurate self-knowledge also showed accurate other-person knowledge, and both accuracy measures were related to frontal function. The better evidence in support of a dissociation between self- and other-knowledge came from our case study with the confabulatory patient. JS showed impaired knowledge of self, but preserved new other-knowledge. In contrast, patient D.B. (Klein, Rozendal & Cosmides, 2002) presented with preserved knowledge of self, but impaired knowledge of his daughter. The performance of these two patients (i.e. J.S. and D.B) represents a double dissociation between self- and other-person knowledge, and suggests that these two types of knowledge may be represented independently in memory. These are the only two cases that we know of that show a dissociation between self- and other-knowledge, in instances where both of these types of knowledge were acquired premorbidly or postmorbidly. An important distinction between these two studies, however, is that while the case of D.B. seems to be exploring knowledge acquired premorbidly, we investigated knowledge acquired postmorbidly.

The few imaging studies that have contrasted self and other knowledge (Craik et al., 1999; Heatherton et al., 2006; Kelley et al., 2002; Ochsner et al., 2005; Scmitz et al., 2004) have not been conclusive regarding the special status of the self as compared to other-person processing. However, in cases when SR processing results in increased activation compared to OR processing, MPFC and right PFC are usually involved. These brain areas are similar to those compromised in J.S. Evidence from neuropsychological studies may help answer questions regarding the potential unique aspect of the self. Current findings may be important in this regard. However, replication of our results is imperative before strong conclusion can be made about the potential dissociation between self- and other-person knowledge.

IV. “New” Memory Rehabilitation Methods Based on “Old” Knowledge about Memory

Study 3 found that a group of memory-impaired patients with acquired brain damage were able to improve episodic memory as a result of SR and OR processing, as well as emotion using verbal materials (i.e. verb-noun phrases and sentences, respectively). The effects of these processes in memory have long been known to investigators. However, they have not been commonly used in the rehabilitation of individuals with memory disorders.

Both SR and OR processing appear to be equally advantageous for patients, although some patients benefit more than others. The degree of SRE and ORE was related to frontal and memory function in patients. These findings may place at least some boundary conditions on SR and OR benefits, and suggest that they may have less mnemonic benefit in patients with very poor memory or frontal function. Conversely, the degree of memory enhancement from emotion was not related to cognitive function. Thus, it appears to be the case that level of frontal or memory function does not represent a constraint as to which patients may benefit from emotion. Studies of patients with amygdala damage have shown that damage to this brain area results in an inability to improve explicit memory after emotional processing (e.g. Markowitsch et al., 1994; Adolphs et al., 1997; Buchanan et al., 2001; Cahill et al., 1995; Adolphs, Tranel, & Denburg, 2000a, 200b; Adolphs, Denburg, Tranel, 2001; Hamman et al., 1999; Phelps et al; 1998). Given the spatial proximity between the amygdala and hippocampus some patients with traumatic injuries may have damage to both structures. These patients will likely not show memory benefits from emotional processing if the damage to these structures is bilateral.

V. Implications for Neuropsychological Rehabilitation

These findings may have important implications for rehabilitation. Given the profound episodic memory deficits that some patients show, individuals who are close to patients may doubt whether patients know who they are at all. This may affect the way people relate to the patient. It would be important for family members and caregivers to know not only that patients may be unaware of their deficits, but that they are also likely perceiving themselves as they used to be, and not as they are perceived by others. Moreover, even though patients with AD may not have an accurate representation of their current self, they likely do know who their caregiver is. Despite the great losses that AD entails, patients with AD, at least relatively early in the course of the disease seem not to have lost knowledge of other people close to them.

Healthcare professionals should be aware that there may be great variability among patients with different types of memory disorder. This may be helpful not only to find the way to best relate to the patient, but also to best educate family members and caregivers of patients about how patients may be perceiving themselves and others.

Replication and extension of current findings is warranted before effective memory rehabilitation methods are developed based on SR and OR processing, and emotion. Based on findings to date, however, it seems that individuals with memory deficits will likely benefit from SR and OR processing. Further, episodic memory of memory-impaired patients also appears to be improved by emotion, although prior literature suggests that such benefits will likely not occur in the presence of amygdala damage.

Memory disorders have been very resistant to rehabilitation. This underscores the importance of findings new ways to improve memory in people with memory deficits. Given the large number of individuals returning from the war with TBIs, our findings showing that this population can benefit from SR and OR processing, as well as emotion seem particularly relevant at this time. Nevertheless, it is yet to be determined whether individuals suffering from blast injuries, which are the most common in current warfare, can benefit from these same types of processing.

VI. Limitations and Future Directions

Part of the significance of the present work lies in the fact that it is, to our knowledge, one of the firsts in a number of ways. First, although a few case studies have examined self-knowledge in memory-impaired patients, our study was the first to do so in a group of MCI and AD patients, only the second in a group of patients with acquired brain damage (the first of which was conducted by our laboratory), and the first to explore trait self knowledge in confabulation objectively. Second, it was also the first to explore the effect of OR processing and only the second study to explore the benefits of SR processing in memory-impaired patients (the first one also conducted by our group). Additionally, it was the first to explore the effects of emotion in patients with memory impairment as a result of TBI. Ironically, the main drawbacks of the current study fall on the fact that it was the first of its kind in several respects. Because of this, replication and extension of this research is imperative before more definitive conclusions can be reached. Further research should take into account some of the caveats to our study, which are delineated below.

First, the instruments used to test self-knowledge clearly have limitations, and interpretations based on these measures remain tentative. We have attempted to make findings based on these instruments more meaningful by contrasting self-knowledge to other-knowledge, and asking both patients and controls to complete these measures. However, it is still difficult to interpret findings showing inconsistencies between the ratings of patients and their informants. To improve these measures, it might be worth gathering additional objective information about the relationship between patients and controls, such as amount of time spent together per week, type and number of activities that are performed together, and observed quality of interaction.

Second, to date we have used single words and verb-noun phrases to test the SRE, and only verb-noun phrases to test the ORE. We have also used relatively short delays in testing for these effects. In order to explore the extent of applicability that these types of processing might have in memory rehabilitation, future studies may test at least paragraph length material and longer delays. An additional next step in the study of the applicability that self- and other-referential processing and emotion may have in memory rehabilitation will be to determine further which memory-impaired patients might not benefit from these strategies.

Another limitation of the present study concerns the fact that we have only started to explore some of the factors that have been proposed to be important in understanding mechanisms underlying the SRE in normal individuals. The impact that these variables could have on the SRE in patients awaits further research.

The final limitation of the present study was the small group size, which may have prevented us from detecting some differences that might indeed exist.

VII. Conclusion and Future Directions

To conclude, the present study found that person knowledge may be affected differently by different memory disorders, but at least some memory-impaired patients can have a preserved sense of self and know the personality of other people close to them. Our findings also indicate that SR, OR and emotion can be powerful encoding devices for memory-impaired patients. This study represents an attempt to integrate knowledge from different areas in psychology with the goal to aid in the rehabilitation of memory-impaired individuals. It might prove to be an important step in understanding how best to relate to the memory-impaired patient, and in the development of new techniques in memory rehabilitation.

APPENDIX

Mean Proportions (*SDs*) of Hits and False Alarms by Stimulus Type (Neutral and Emotional) for TBI Patients and Controls

	Stimulus Type	
Group	Neutral	Emotional
Patients[a]		
Hits	.55 (.33)	.72 (.23)
False Alarms	.12 (.17)	.09 (.15)
Controls[b]		
Hits	.76 (.16)	.95 (.05)
False Alarms	.10 (.10)	.10 (.11)

[a] n = 8, 3 females; Age: *M* = 47.38, *SD* = 9.96; Education: *M* = 13.00, *SD* = 2.33
[b] n = 8, 3 females; Age: *M* = 48.38, *SD* = 10.26; Education: *M* = 13.25, *SD* = 1.83

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