EXAMINING THE SELF-REFERENCE EFFECT IN HEALTHY AGING AND AMNESTIC MILD COGNITIVE IMPAIRMENT

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Abstract

This dissertation investigates the *Self-Reference Effect* (SRE), enhanced memory for self-related information, in terms of its ability to enhance episodic memory in healthy aging and amnestic Mild Cognitive Impairment (aMCI). Additionally, the persistence of the SRE over time is examined in healthy aging and aMCI. The dissertation furthermore explores the ability of self-referential processing to enhance recollection memory in healthy aging and aMCI (known as the *Self-Reference Recollection Effect*), and whether stimuli valence influences memory in these populations. In Experiment 1, the SRE was studied in healthy aging and aMCI for trait adjectives, the most common form of stimuli utilized in SRE research. Results indicated that while the healthy aging group benefitted from self-referential encoding in terms of overall recognition memory and enhanced recollection, the aMCI group did not specifically benefit from self-referential processing over that of semantic encoding, indicating an effect of "deep encoding" in general. Stimuli valence was not shown to influence memory in either group. In Experiment 2, the SRE was investigated in healthy aging and aMCI for narrative information, thought to be more meaningful than individual trait adjective words. A test of narrative cued recall showed an SRE in healthy aging but not in aMCI. The SRE was found in both populations on a test of recognition. Additionally, while self-referential encoding improved recollection for narrative material in healthy aging, it did not show effects over and above that of semantic encoding in aMCI. Cued recall was higher for negative versus positive details in both groups, however there was no influence of valence on recognition of narrative details. Experiment 3 examined whether the benefits of self-referential processing continue to appear following a one-week delay in healthy aging. The SRE for both trait adjectives and narrative information was shown to persist following the delay, and improved recollection also remained present for self-referenced material. Cued recall of narrative details did not show extra benefit for self-referenced material at follow-up testing. Enhanced recall was specifically evident for negatively valenced narrative details, as was improved recollection. Experiment 4 investigated whether the persistence of the SRE found in Experiment 3 in healthy aging extends to those with aMCI. Results indicated that while individuals with aMCI did show a mnemonic advantage for self-referenced narrative material following a one-week time delay, they still benefitted from "deep encoding" in general. Recollection similarly continued to improve with "deep encoding" processes following a delay. In cases where valence preferences were found, they were in the direction of a negativity bias. The dissertation findings presented here extend previous research and uniquely contribute to our understanding of the SRE and deep encoding strategies in healthy aging and in aMCI by demonstrating the following: 1) The SRE reliably extends to narrative information; 2) The SRE specifically advantages memory over time in healthy aging; 3) In aMCI, observation of an SRE may be dependent on the type of information to be encoded (for example, trait adjective versus narrative information); and 4) "Deep encoding" strategies in general appear to benefit memory over time in aMCI.

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List of Acronyms

SRE = Self-Reference Effect

SRRE = Self-Reference Recollection Effect

aMCI = amnestic Mild Cognitive Impairment

AD = Alzheimer's disease

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CHAPTER 1

General Introduction

For the first time in Canadian history, the number of individuals aged 65 and older outnumber those less than 15 years of age (Statistics Canada, 2017). The population of older adults in Canada is growing exponentially and by the year 2051, this demographic is expected to comprise approximately a quarter of the Canadian population (Statistics Canada, 2016). With these changing population demographics, it is crucial to understand and develop healthcare practices for conditions common in older age, both physical and cognitive. Cognitive changes in aging are common. Some changes are considered to be associated with healthy cognitive aging, while others are thought to represent age-related disease. The present dissertation focuses on memory changes in healthy and pathological cognitive aging and a potential intervention strategy, the *Self-Reference Effect* (SRE), enhanced memory for self-related information, which may be used to compensate for memory deficits in these populations. The overarching aims of the dissertation research were to establish whether the SRE improves memory in healthy aging and amnestic Mild Cognitive Impairment (aMCI), a condition thought to represent a transition between healthy cognitive aging and Alzheimer's type dementia, and also to investigate the longevity of the SRE strategy in these populations. The following general introduction outlines the changes (and stability) of different memory processes in healthy aging and aMCI and also introduces the SRE and factors that have been shown to be related to the effectiveness of the strategy.

Memory Processes in Healthy Aging

It is well established that memory declines with healthy aging, but not all memory processes are affected to the same extent. *Personal semantic memory*, memory for general information about the self, has been shown to be better preserved than *autobiographical episodic memory*, memory for personal events tied to a specific time and place (Allen, Sliwinski, Bowie, & Madden, 2002; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Nyberg, Bäckman, Erngrund, Olofsson, & Nilsson, 1996; Piolino et al., 2006; Piolino, Desgranges, & Eustache, 2009). Recognition memory is the ability to identify material that was presented previously. Within recognition memory, *familiarity*, a sense of having been previously exposed to information without details of context, appears to be better preserved in healthy aging than *recollection*, the re-experiencing of a past event, including its context (Bastin & Van der Linden, 2003; Java, 1996; Light, Prull, La Voie, & Healy, 2000; Mäntylä, 1993). The current dissertation examines whether through use of memory processes that are generally spared in healthy aging and age-related disease, it is possible to improve those that are vulnerable to decline. The SRE capitalizes on personal semantic memory, a memory process generally spared in healthy aging and age-related disease, and may thus represent an avenue for memory compensation in these populations.

The Self-Reference Effect (SRE)

The SRE was first revealed in a study conducted by Rogers, Kuiper, & Kirker (1977), which was designed as an extension of the *Depth of Processing* approach (Craik & Lockhart, 1972; Craik & Tulving, 1975), based on findings that the amount of processing or "depth" with which a stimulus is encoded influences later memory. For example, an encoding task that requires participants to decide whether a word describes a living creature is thought to involve "deep" encoding and elicits better memory than deciding whether a word contains a certain letter, which is thought to involve "shallow" encoding. The initial study of the SRE by Rogers et al. asked participants to judge trait adjective words (such as *kind*, *funny*, *liar*) under four encoding conditions: self-reference ("Describes you?"), semantic ("Means the same as ______?"), phonemic ("Rhymes with ______?"), and structural ("Big letters?"). Results showed that encoding information in relation to the self promoted memory even more than the semantic condition, despite both conditions involving "deep" encoding, certainly in comparison to "shallower" phonemic and structural conditions. The authors concluded, "…The self appears to function as a superordinate schema that is deeply involved in the processing, interpretation, and memory of personal information" (p. 677).

The seminal paper by Rogers et al. (1977) prompted extensive research on the SRE, and over the past 40 years, the effect has been established as a robust phenomenon. Many investigators have pursued research into how exactly the SRE operates. A meta-analysis by Symons and Johnson (1997) systematically analyzed this body of research, and concluded that the SRE uniquely promotes spontaneous *elaboration* and *organization*, making self-referenced information easier to retrieve than that encoded through other types of processing.

Elaboration. Rogers et al. (1977) attributed the SRE to more elaborative processing in the self-reference encoding condition than in the other conditions. Elaboration provides item-specific processing of material, which increases the number of routes by which encoded information can be retrieved (Klein & Loftus, 1988). Furthermore, as discussed in Symons & Johnson (1997), humans naturally consider the self when processing information and are especially practiced and efficient at using this mode of elaborative processing (Catrambone, Beike, & Niedenthal, 1996; Catrambone & Markus, 1987; Fong & Markus, 1982). From this perspective, the self-reference manipulation in SRE studies capitalizes on a natural way of information processing that we use in daily life.

Organization. In contrast to elaboration, which involves item specific processing, organization involves relational processing between items. Klein and Kihlstrom (1986) argued that the SRE is due to the relational processing (organization) that is inherent in self-reference conditions, which require participants to categorize words into "Describes me" and "Doesn't describe me" categories. When Klein and Kihlstrom equated self-reference and semantic encoding conditions in terms of the promotion of organizational processing, the SRE disappeared. Further research by Klein and colleagues provided additional evidence that organization is an important component to the SRE (Kihlstrom et al., 1988; Klein & Loftus, 1988; Klein, Loftus, & Schell, 1994).

Self-reference versus other-reference. In attempting to determine whether the self has unique properties that promote memory, previous studies have compared self-referential encoding to other-referential encoding involving consideration of a familiar person. "Familiar others" range across studies in terms of intimacy, for example, some studies include a public figure such as Johnny Carson or a current president, while others ask participants to choose a highly familiar person in their lives to consider in the "other-reference" encoding condition. Early studies incorporating a "familiar other" indicated that when comparing memory from self-reference conditions to other-reference conditions, the SRE reduced in magnitude or disappeared altogether (Bower & Gilligan, 1979; Kuiper, 1982; Kuiper & Rogers, 1979). Symons & Johnson's (1997) meta-analysis confirmed that across SRE studies, the benefit of self-referential processing was reduced when compared to a familiar other person, however it was not eliminated. Furthermore, the magnitude of the SRE was influenced by the intimacy between participant and individual chosen as the "other-reference". For example, the difference between the self-reference and other-reference conditions was larger when the "other-reference" was a public figure with whom the test participant had little personal contact. When the "other-reference" was someone who the participant knew well (for example, their mother), however, self-referential processing showed less of a memory advantage.

Nature of the SRE task. An additional factor to take into consideration in understanding how the SRE benefits memory is the type of task that is used. The majority of studies administer trait adjective paradigms to investigate the SRE, similar to the original Rogers et al. (1977) study. These paradigms require participants to encode trait adjective words (such as *calm, friendly, liar*) under different conditions, including: self-reference (e.g., "Does this word describe me?"), and some form of other-reference (e.g., "Does this word describe Johnny Carson" or "Does this word describe your mother?"), semantic (e.g., "Does this word describe a desirable personality trait?"), and/or structural/baseline ("Does this word contain a capital letter"?) conditions for comparison. Memory is subsequently tested using a recall or recognition test. Though trait adjective paradigms are most common in SRE research, the SRE has also been found for other types of material such as nouns (Maki & McCaul, 1985; Trelle, Henson, & Simons, 2015), objects (Dulas, Newsome, & Duarte, 2011; Hamami, Serbun, & Gutchess, 2011; Leshikar & Duarte, 2012; 2014; Rosa & Gutchess, 2011; Serbun, Shih, & Gutchess, 2011), and narrative information (Carson, Murphy, Moscovitch, & Rosenbaum, 2016; Grilli & Glisky, 2010, 2011; Grilli, Woolverton, Crawford, & Glisky, 2017; Reeder, McCormick, & Esselman, 1987).

The nature of the self-reference encoding condition itself has also been varied in past research. Some studies have used a self-reference encoding manipulation that relies on autobiographical episodic memory, for example, asking participants to think of a personally experienced event when presented with a word (e.g., Bower & Gilligan, 1979; Klein & Kihlstrom, 1986; Klein & Loftus, 1988; Klein, Loftus, & Burton, 1989; Grilli & Glisky, 2013;

Trelle et al., 2015). However, a more common approach is to use a self-reference condition that relies on personal semantic memory, asking participants to decide whether a word is self-descriptive (e.g., Carson et al., 2016; Craik et al., 1999; Ferguson, Rule, & Carlson, 1983; Fossati et al., 2003; 2004; Genon et al., 2014; Glisky & Marquine, 2009; Gutchess, Kensinger, Yoon, & Schacter, 2007; Klein & Kihlstrom, 1989; Kuiper & Rogers, 1979; Lalanne, Rozenberg, Grolleau, & Piolino, 2013; Leblond et al., 2016; McCaul & Maki, 1984; Pullybank et al., 1985; Rogers et al., 1977). The nature of the self-reference encoding condition and its effect on the occurrence of the SRE has been considered in a handful of studies. Klein, Loftus, & Burton (1989) found that the SRE was equivalent, regardless of whether an autobiographical episodic or personal semantic encoding manipulation was employed. However, in more recent studies on individuals showing decline in autobiographical episodic memory due to acquired brain injury (Grilli & Glsiky, 2013) and healthy aging (Trelle et al., 2015), the self-reference condition that relied on personal semantic memory promoted memory more than that relying on autobiographical episodic memory. This finding is particularly relevant to the current dissertation, which investigates the SRE in healthy aging and in mild cognitive impairment.

The SRE in Healthy Aging

The SRE is established as a robust phenomenon in younger adults (see Symons and Johnson, 1997 for a review). Perhaps surprisingly, few studies have investigated its application to older adults experiencing normal memory decline, and even fewer have investigated its potential benefits in age-related disorders that affect autobiographical episodic memory, such as amnestic mild cognitive impairment (aMCI) and Alzheimer's disease (AD).

A study by Gutchess et al. (2007), investigated the SRE in healthy aging and sparked recent interest in examining the phenomenon in older adulthood. Across three studies, older adults showed an SRE when memory for trait adjectives encoded in the self-reference condition was compared to those encoded in other-reference and structural conditions. The study also indicated that the degree to which older adults benefitted from the SRE was influenced by individual cognitive resources (measured by processing speed). Though the SRE was not found to improve memory in older adults to the same extent as younger adults, it was encouraging to find that the self-reference strategy benefitted memory in healthy aging.

A subsequent study by Glisky and Marquine (2009) furthered the investigation of the SRE in older adults by broadening the age range of participants tested (resulting in a "younger-older" group of individuals aged 66-75 and an "older-older" group of participants aged 76-91) and exploring the contributions of executive functioning and episodic memory on the SRE. Using a trait adjective paradigm, this study found that the SRE persisted into very old age. While results did not indicate that individual executive functioning influenced the SRE, basic memory function did.

The investigation of the SRE in healthy aging has indeed gained recent popularity, and the phenomenon has been established across a number of studies, including those detailed above (Carson et al., 2016; Genon et al., 2014; Glisky & Marquine, 2009; Gutchess et al., 2007; Leblond et al., 2016; Mueller, Wonderlich, & Dugan, 1986; Rosa, Deason, Budson, & Gutchess, 2015; Rosa & Gutchess, 2013). The SRE has been found in healthy aging for different types of stimuli, such as narratives (Carson et al., 2016; Grilli et al., 2017), objects (Dulas, et al., 2011; Hamami et al., 2011; Leshikar & Duarte, 2014; Rosa et al., 2011; Rosa, Deason, Budson, & Gutchess, 2016), and nouns (Trelle et al., 2015), however, similar to young adults, the majority of SRE studies in aging have used common trait adjective paradigms. Though trait adjective paradigms commonly capitalize on personal semantic memory, a process that appears to remain stable in the face of episodic memory decline associated with healthy aging (Allen et al., 2002; Levine et al., 2002; Nyberg et al., 1996; Piolino et al., 2006; Piolino et al., 2009), trait adjective words are unlikely to simulate real-world demands on memory.

The SRE for Narrative Information

Narrative material engages different and much richer processes than single words (Xu, Kemeny, Park, Frattali, & Braun, 2005), and neuroimaging studies show that distinct brain regions are implicated in lab-based tests of episodic memory involving recognition of single words versus real-world tests of autobiographical episodic memory involving recall of personal narratives (e.g., Gilboa, 2004; McDermott, Szpunar, & Christ, 2009). The incorporation of complex and meaningful narrative material as stimuli represents a more ecologically valid approach to investigating the utility of the SRE for enhancing memory in healthy aging and age-related disease. Previous work has suggested ecologically valid applications of self-related processing in healthy aging, such as in the enhancement of source memory for remembering whether it was the self or others who performed a specific action (Rosa & Gutchess, 2011; Rosa et al., 2016). Memory for narrative information is integral to everyday functioning, as it characterizes communications of our own life experiences and allows us to gather knowledge about others (Kropf & Tandy, 1998). We communicate in everyday life in a manner that resembles storytelling (Miller, 1995). The integration of personal narratives has been thought to influence the overall coherence of self-identity (Mar, Peskin, & Fon, 2010) and the maintenance of a coherent sense of self through time (Bluck & Habermas, 2000; Tulving, 2002).

Nevertheless, previous research demonstrates that older adults exhibit impaired memory for narrative information when compared to their younger adult counterparts (Byrd, 1985; Hultsch & Dixon, 1984; Olofsson & Backman, 1993; Surber, Kowalski, & Pena-Paez, 1984;

Zelinski, Light, & Gilewski, 1984). These deficits extend to autobiographical narratives, with older adults showing a decline in memory for specific details of past personal events, and episodic memory more generally (Addis, Musicaro, Pan, & Schacter, 2010; Addis, Wong, Schacter, 2008; Levine et al., 2002; Piolino at al., 2006, 2009; Schacter, Gaesser, & Addis, 2013). The SRE may provide a unique way to improve memory for the narrative information that is inherent in vividly recalling the unfolding of a past personal event.

There are few studies that have investigated the SRE for narrative information in young and older adults. An early study by Reeder et al. (1987) showed that memory for personality profiles is enhanced when self-referential processing is emphasized during reading. More recently, Grilli and Glisky (2010) found that self-referencing is an important component in promoting recognition of narrative information. In their study, individuals with neurological damage (primarily traumatic brain injury) and healthy controls encoded sentences under conditions that emphasized either self-specific, semantic, or structural encoding. Their findings indicated a *Self-Imagination Effect* (SIE), where sentences imagined from a personal perspective promoted enhanced recognition when compared to those in the other conditions. In addition to finding that the SRE promoted memory for narrative information, their research also importantly showed that the SRE improved memory in those with pathological forms of memory change.

Encouraged by the findings of an SRE for narrative information in a memory-impaired population, Carson et al. (2016) investigated whether the SRE improved memory for short narratives (3-4 sentences in length) in healthy older adults, a population who experiences typical episodic memory decline. Participants encoded narratives under self-reference ("Can I easily imagine myself experiencing this event?"), semantic ("Does the story describe a positive event?"), and structural ("Does the word 'the' appear more than 4 times?") encoding conditions and were subsequently tested with tests of recall and recognition. Results indicated that healthy older adults showed an SRE for narrative information. These findings were encouraging and inspired the work comprising the current dissertation, which investigates whether the SRE can be extended to improve memory in neuropathalogical models of aging, such as amnestic Mild Cognitive Impairment.

Amnestic Mild Cognitive Impairment (aMCI) and the SRE

Amnestic Mild Cognitive Impairment (aMCI) is a clinical classification that represents a greater than age-expected decline in memory but without marked decline in level of independence in managing complex activities of daily living (e.g., household chores, cooking, banking, scheduling). It is considered an intermediate stage between healthy aging and dementia. Having aMCI is a high risk factor for the development of Alzheimer's disease (AD), with 80% of those diagnosed with aMCI converting to dementia within 6 years (Petersen et al., 1999, 2001). Autobiographical episodic memory is notably impacted in aMCI, while personal semantic memory remains relatively intact (Barnabe, Whitehead, Pilon, Arsenault-Lapierre, & Chertkow, 2012; Gamboz et al., 2010; Murphy, Troyer, Levine, & Moscovitch, 2008; cf. Leyhe, Müller, Milian, Eschweiler, & Saur, 2009; Irish, Lawlor, O'Mara, & Coen, 2010). The ability to recall past personal events is critical to the maintenance of a sense of self and continuity through time (Conway, 2005; Tulving, 2002), and the sharp decline of this ability is likely linked to the functional changes that are exhibited as one progresses from aMCI to AD. The differential diagnosis of aMCI versus AD hinges on relatively intact instrumental activities of daily living (Albert et al., 2011), which have been shown to rely on episodic memory processes (Koehler et al., 2011; Tomaszewski Farias et al., 2009). Through use of the SRE, it may be possible to capitalize on intact personal semantic memory to promote episodic memory in aMCI, as has been achieved in healthy older adults.

To date, there has been limited study of the SRE in aMCI. Leblond et al. (2016) employed a commonly used trait adjective paradigm to test the SRE, with participants encoding positive and negative trait adjective words under self-reference ("Does this adjective describe you?"), other-reference ("Does this adjective describe [a famous French individual]?"), or semantic ("Is this a positive adjective?") conditions. Results indicated that while healthy older adults showed an SRE regardless of the valence of the trait adjectives, those with aMCI showed an SRE only for positive trait adjectives. The authors suggested that this discrepancy might be due to a positivity bias in aMCI with a tendency to dismiss words that reflect negative information about the self.

A study by Rosa et al. (2015) investigated the SRE in healthy aging and aMCI, with a specific focus on whether there were more false memories (false alarms) for trait adjectives considered to be highly self-descriptive. While healthy controls showed an SRE, individuals with aMCI did not show improved memory for self-related words over those encoded in a semantic condition. Furthermore, contrary to expectations, relative to controls, individuals with aMCI did not exhibit increased susceptibility to false alarms for self-descriptive words.

A further study by Rosa et al. (2016) provided insight into self-related memory in aMCI by employing a unique experimental design, rarely used in SRE research. The authors investigated whether item memory and source memory would be improved in aMCI when individuals used "self-performing actions." Participants, along with a close other and the experimenter, packed a suitcase and a picnic basket, each taking turns placing objects inside.

Results indicated that personally packing an item ("self-performing") enhanced item memory in aMCI, but did not improve source memory for the items.

Despite limited investigation of the SRE in aMCI, the few studies researching the SRE in other memory-impaired populations shed some light on the effectiveness of the technique in older adults with mild to moderate memory difficulties. Studies of the SRE in AD have shown mixed results, with two studies indicating no SRE (Genon et al., 2014; Lalanne et al., 2013) and another showing that the SRE benefits memory in AD (Kalenzaga & Clarys, 2013). Leblond et al. (2016) also included a group with AD in their study of the SRE, but concluded that floor effects and a small sample size prevented appropriate analyses. Furthermore, as mentioned previously, studies of the *Self-Imagination Effect* have indicated that memory in amnesic individuals (primarily due to traumatic brain injury) improved through the process of imagining oneself in a specific context or performing a certain task (Grilli & Glisky, 2010, 2011, 2013; Grilli & McFarland, 2011). Grilli and Glisky (2010) was in fact one of the first studies to investigate the SRE for meaningful narrative information, which might indicate a more ecologically valid application of the strategy than findings of the SRE in single trait adjective words.

The SRE for Narrative Information in aMCI

The SRE may be particularly well-suited as a strategy for boosting autobiographical episodic memory and the narrative information that comprises it, especially in aMCI, which is associated with declines in these domains. In clinical neuropsychological assessment, story recall tests, such as the Logical Memory subtest of the Wechsler Memory Scale (Wechsler, 1984, 1997a, 2009), are commonly used as a key indicator of episodic memory decline. These tests generally involve presenting individuals with a brief prose passage (story) and then asking them to recall the story after short and long time delays (some versions also include a recognition test). Results of story recall tests commonly indicate poor performance in those with aMCI when compared to healthy older counterparts (e.g., Belleville et al., 2006; Cunje, Molloy, Standish, & Lewis, 2007; Hua et al., 2008; Nordlund et al., 2005; Wang & Zhou, 2002), providing further evidence that narrative memory is a notable area of difficulty within this population.

Previous research has recognized the narrative memory deficit in MCI and attempted to alleviate it, but with little success. For example, a study by Belleville et al. (2006) tested an intervention for narrative memory in MCI that involved education about the "hierarchical organization of texts" and teaching individuals to use a strategy called the PQRST (Preview, Question, Read, State, Test) method. Unfortunately, this method proved to be ineffective, however the study increased awareness about the memory loss for narrative information in MCI and the need to find methods of remediation.

Though few other studies have investigated how narrative memory may be improved in MCI, encouragingly, the limited number of studies conducted in other memory-disordered populations (primarily with traumatic brain injury) have indicated that self-related processing can be used to effectively improve memory for this type of material in individuals experiencing pathological memory changes (Grilli & Glisky, 2010, 2011, 2013; Grilli & McFarland, 2011). As mentioned above, a study by Carson et al. (2016) built on this research to show that the SRE improved narrative memory in those experiencing normal age-related memory decline. A recent study by Grilli et al. (2017) found that cognitively intact older adults at greater risk for developing AD due to being carriers of the ε4 polymorphism of apolipoprotein E (APOE) benefitted from the SRE for narrative information to the same extent as older adults who were not carriers. Taken together, studies in individuals with memory decline due to brain injury, healthy aging, and at risk for developing AD indicate that the SRE has great potential as a strategy to enhance narrative memory in aMCI.

The Self-Reference Recollection Effect (SRRE)

Self-referential processing appears to improve overall episodic memory in healthy and memory-impaired populations, but there is additional suggestion in the literature that it may operate on specific aspects of memory, such as episodic retrieval experience (i.e., recollection). Recollection for re-experiencing contextual information is known to be especially vulnerable to changes in healthy aging (Bastin & Van der Linden, 2003; Java, 1996; Light, Prull, La Voie, & Healy, 2000; Mäntylä, 1993), and these changes are even more pronounced in aMCI. In contrast, familiarity that an event was experienced in the past but without access to rich contextual details remains relatively preserved (e.g., Anderson et al., 2008; Hudon, Belleville, & Gauthier, 2009; Irish et al., 2010; Serra et al., 2010; Westerberg et al., 2006; cf. Koen & Yonelinas, 2014). The retrieval experience associated with processing material in different ways at encoding can be investigated through a remember/know decision at recognition. During the recognition test, when a participant indicates that an item as have been previously studied, they are then asked to indicate the retrieval experience associated with this memory, with a "remember" endorsement indicating recollection and a "know" endorsement indicating familiarity (Gardiner & Richardson-Klavehn, 2000; Tulving, 1985). Previous studies indicate that self-referential encoding is related to higher rates of "remembering" (recollective or episodic experience) than are other types of encoding that promote higher rates of "knowing" (feelings of familiarity; Conway & Dewhurst, 1995; Conway, Dewhurst, Pearson, & Sapute, 2001). This phenomenon, termed the *Self-Reference Recollection Effect* (SRRE) by Conway and Dewhurst, has been demonstrated in subsequent research in younger adults (Leshikar & Duarte, 2012; van den Bos, Cunningham, Conway, & Turk, 2010) and healthy older adults (Carson et al., 2016; Genon et al., 2014; Leshikar, Dulas, & Duarte, 2015). Studies of the SRRE have primarily used trait adjectives as stimuli. However, since narratives are more detailed and context-rich, they may elicit higher rates of recollection than other types of material.

A recent review of the literature indicates that the SRRE has not been researched in aMCI. Similar to studies of the SRRE in healthy aging (Carson et al., 2016; Genon et al., 2014; Leshikar et al., 2015), self-referential processing may lead to improved recollection in aMCI. The three studies to date that have examined the SRRE in AD found that self-referential processing improved recollection, though Lalanne et al. (2013) found an SRRE in AD only for positive trait adjectives and Kalenzaga and Clarys (2013) and Kalenzaga et al. (2013) found an SRRE exclusively for negative trait adjective words. Given that the SRRE has been shown to promote recollection in healthy aging and in AD, it seems likely that those with aMCI would likewise benefit, potentially less than in healthy aging and more than in AD. Based on previously reviewed studies, consideration as to the valence of stimuli was also of interest based on past research (e.g., Leblond et al., 2016) that has shown valence might determine the presence of an SRE and SRRE.

Influence of Valence on the SRE and SRRE

The influence of valence on memory has been an area of focus in previous SRE and SRRE studies. Research investigating older adults has made predictions consistent with *socioemotional selectivity theory*, which posits that older adults are biased towards memory for positive versus negative information (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005). However, not all studies of cognitive aging support an age-related positivity bias (e.g., Denburg, Buchanan, Tranel, & Adolphs, 2003;

Grühn, Smith, & Baltes, 2005; Fernandes, Ross, Wiegand, & Schryer, 2008; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Murphy & Isaacowitz, 2008). Similarly, there have been mixed findings relating to valence preferences across the lifespan in investigations of the SRE and SRRE. For example, Leshikar et al. (2015) investigated the role of valence in the manifestation of the SRRE in healthy younger and older adult groups, and found that recollection was higher for positive versus negative information in both age groups. Furthermore, previous studies specifically investigating the influence of self-referential processing on memory for trait adjectives in healthy aging have shown enhanced memory in younger adults for negative items but no difference in valence preference in older adults (Glisky & Marquine, 2009) and similar negative valence preferences across the lifespan (Gutchess et al., 2007, Experiment 2). Carson et al. (2016) found a positivity bias specific to healthy older adults in their study of the SRE for trait adjectives, however, an examination of the SRE for narrative information showed better cued recall for negative details across older and younger groups, and no effect of valence on a test of narrative recognition.

The single study that has examined the influence of valence on the SRE in aMCI (Leblond et al., 2016) found that while healthy older adults exhibited no valence preferences associated with the SRE, individuals with aMCI showed the SRE only for positively valenced trait adjectives. This finding is consistent with other research (not specifically investigating the SRE) that has showed a positivity bias in aMCI (Brueckner & Moritz, 2009; Werheid et al. 2010) but inconsistent with another study that found a negativity bias in aMCI attributed to emotional dysregulation caused by neuropathology targeting limbic structures (Mah, Anderson, Verhoeff, & Pollack, 2017). Whether material valence influences the SRE continues to be debated in the literature. Only one published study has specifically examined this issue in aMCI (Leblond et al., 2016); building on this research was a goal of Experiments 1 and 2 of the current dissertation.

False Alarms and the SRE

The majority of SRE studies use recognition tests to examine memory, requiring a measure of "false alarms" or new items that were falsely endorsed as having been studied. Studies of the SRE in aging have found that older adults make more false alarms than their younger counterparts (Glisky & Marquine, 2009; Gutchess et al., 2007, Experiment 1) and are particularly prone to making false endorsements of positive material (Carson et al., 2016; Glisky & Marquine, 2009; Gutchess et al., 2007, Experiment 1). Glisky and Marquine (2009) attributed these findings to evidence that positive information is remembered in a more gist-like, general fashion (see Kensinger, Garoff-Eaton, & Schacter, 2007), making it more difficult to distinguish between studied items and unstudied, distractor items. The extent to which material is self-descriptive may further influence false memory in aging. Rosa et al. (2011) investigated false alarms made by healthy older adults completing a SRE task, and found that the more participants found a trait adjective to be self-descriptive, the more likely they were to endorse the word on a recognition test (when the word was in fact not seen before). This pattern of results was also found when the authors tested individuals with aMCI (Rosa et al., 2016). Self-referential processing therefore at once improves memory in aging while also reducing accuracy, due to an increased susceptibility to false alarm for self-descriptive material.

The SRE as an Intervention for Episodic Memory

The SRE has been shown to improve episodic memory in populations that generally exhibit decline or impairment in this ability, including healthy aging (Carson et al., 2016; Dulas, et al., 2011; Genon et al., 2014; Glisky & Marquine, 2009; Gutchess et al., 2007; Hamami et al., 2011; Leblond et al., 2016; Leshikar & Duarte, 2014; Mueller et al., 1986; Rosa et al., 2011; 2015; 2016; Trelle et al., 2015), aMCI (Leblond et al., 2016; Rosa et al., 2015; 2016), AD (Kalenzaga & Clarys, 2013; cf. Genon et al., 2014; Lalanne et al., 2013), and acquired brain injury (Grilli & Glisky, 2010, 2011, 2013; Grilli & McFarland, 2011). Many of these studies suggest that the SRE could serve as a valuable intervention strategy for improving episodic memory in memory-disordered populations. However, there has been limited research into whether the SRE persists following the one test session during which an individual participates in an SRE experiment. The viability of the SRE as an intervention hinges on its sustainability in promoting continued, long-term improvement in memory.

Seminal studies by Conway & Dewhurst (1995) and Conway et al. (2001) revealing the SRRE are the only studies to consider how the SRE and SRRE are influenced by time. These studies found that the SRRE was only apparent following at least a one-hour retention interval between study and test, and that the effect was also found after a retention interval of over 24 hours. Though these studies are informative, they are limited in their ability to predict the "maintenance" of the SRE over time in memory-disordered populations, as it is unknown whether participants initially showed an SRE and how the effect fared beyond 24 hours (e.g., the authors did not consistently find an overall SRE and it is unclear whether the effect was initially apparent and then faded). Additionally, the experiments by Conway and colleagues were conducted in healthy young adults, and the results may not generalize to healthy older adults or memory-disordered populations. Last, in their emphasis on trait adjectives, these studies do not speak to the effects of the SRE and SRRE over time for more ecologically valid information.

Current Gaps in the SRE Literature

Though research on the SRE has increased in popularity over the past decade, notable gaps remain in the literature that require further study. The ability of the SRE to improve memory for narrative information has had limited investigation, and as noted above, memory for this type of information has greater potential for real-world applications than trait adjectives words, which are traditionally examined in SRE studies. Furthermore, narrative information comprises autobiographical episodic memory, an area of notable decline in healthy and pathological aging, including aMCI or AD. There have been only a few studies of the SRE in certain memory-disordered populations, including those with AD, and even fewer in aMCI. It is also currently unknown whether self-referential processing improves the process of recollection in aMCI (i.e., elicits an SRRE). Given that those with aMCI suffer from decline in episodic memory and related memory processes (i.e., recollection), a strategy like the SRE may significantly benefit this population. Finally, there are studies in the literature that allude to the use of the SRE as a cognitive intervention technique for those experiencing memory change, however, it has yet to be established whether the effects of the SRE last beyond one day in populations experiencing episodic memory difficulties. It is crucial to investigate whether the benefits of the SRE are maintained over an extended period of time in order to ascertain whether it may truly represent an effective memory intervention technique.

Overview of Experiments

Based on areas of limited research in the SRE literature, the series of experiments that comprise this dissertation had two overarching goals: (1) to establish whether the ability to improve memory for trait adjectives and narrative material in healthy younger and older adults using the SRE extends to older adults with aMCI, and (2) to investigate whether gains to memory due to the SRE are maintained over an extended period of time, contributing to the promise of the SRE as a viable intervention for improving memory in healthy older adults and individuals with aMCI. Experiment 1 sought to investigate the SRE in healthy aging and aMCI using a commonly employed trait adjective paradigm. Furthermore, the SRRE was examined for the first time in aMCI. It was important to test the SRE and SRRE in aMCI using a trait adjective paradigm, as this type of research design has elicited the most consistent and robust SRE across studies. Experiment 2 aimed to extend the SRE to improve memory for narrative information in aMCI. Because narrative information is more ecologically valid than single trait adjectives, improvement with self-referential strategies would likely be more applicable to real-world functioning. The narrative paradigm administered in Experiment 2 was based on the paradigm designed to test the SRE for narrative information in healthy young and older adults (Carson et al., 2016), and mirrored established trait adjective paradigms. The SRRE for narrative information was also examined for the first time in aMCI. The goal of Experiment 3 was to determine whether the SRE is maintained over a one-week delay in healthy aging, providing evidence that the strategy may provide an effective way to improve episodic memory over time in a population that exhibits a decline in episodic memory. The effect of time on the maintenance of the SRRE was also examined for the first time in healthy aging. Both trait adjective and narrative paradigms were administered to compare effects for different types of stimuli. Experiment 4 furthered the investigation of the maintenance of the SRE by testing whether the strategy continues to benefit memory in aMCI following a one-week delay. The potential influence of valence on the SRE and SRRE was investigated across all four experiments included in the current dissertation. In summary, the experiments presented in this dissertation examined whether: the SRE can be extended to improve memory in aMCI for trait adjectives and narratives, recollection is enhanced with self-referential processing in aMCI (i.e., an SRRE), material valence influences these effects, and whether the SRE and SRRE are maintained over time in healthy aging and aMCI.

CHAPTER 2

Experiment 1: The SRE for Trait Adjectives in Healthy Aging and aMCI

Increased understanding of memory changes in healthy older adults and in patient populations has led to the development of targeted techniques to help improve memory. Specifically, the SRE has been shown to improve memory in healthy young and older adults, however few studies have examined whether the benefits extend to age-related memory disorders such as aMCI. Two published studies to date have investigated the SRE for trait adjectives in aMCI (Leblond et al., 2016; Rosa et al., 2015). Leblond et al. (2016) asked participants to encode positive and negative trait adjective words under self-reference ("Does this adjective describe you?"), other-reference ("Does this adjective describe [a famous French individual]?"), or semantic ("Is this a positive adjective?") conditions. Results indicated that while healthy older adults showed an SRE regardless of the valence of the trait adjectives, those with aMCI showed an SRE only for positive trait adjectives. Rosa et al. (2015) investigated the SRE in healthy aging and aMCI, with a specific focus on whether there were more false memories (false alarms) for trait adjectives considered to be highly self-descriptive. While healthy controls showed an SRE, individuals with aMCI did not show improved memory for self-related words over those encoded in a semantic condition. The mixed results evident from these two studies indicate that further examination of the SRE for trait adjectives in aMCI is necessary. The goals of Experiment 1 were to evaluate the SRE for trait adjectives in aMCI and to investigate for the first time whether self-referential encoding improves recollection (i.e., the SRRE) in aMCI.

Previous studies have found that self-referential encoding is related to higher rates of "remembering" (recollective or episodic experience) than are other types of encoding that promote higher rates of "knowing" (feelings of familiarity; Conway & Dewhurst, 1995; Conway et al., 2001). The SRRE (Conway & Dewhurst, 1995; Conway et al., 2001) has been demonstrated in subsequent research in younger adults (Leshikar & Duarte, 2012; van den Bos, Cunningham, Conway, & Turk, 2010) and healthy older adults (Carson et al., 2016; Genon et al., 2014; Leshikar, Dulas, & Duarte, 2015), however, no study has examined whether the effect is present in aMCI. Recollection has been shown to decline in aMCI more than in healthy aging (Anderson et al., 2008; Hudon et al., 2009; Serra et al., 2010; Westerberg et al., 2006) and is an important process that may benefit from self-referential strategies.

Three studies to date have examined the SRRE in AD and found that self-referential processing improved recollection, though Lalanne et al. (2013) found an SRRE in AD only for positive trait adjectives and Kalenzaga and Clarys (2013) and Kalenzaga et al. (2013) found an SRRE exclusively for negative trait adjective words. Given that the SRRE has been shown to promote recollection in healthy aging and in AD, it seemed likely that those with aMCI would likewise benefit, potentially less than in healthy aging and more than in AD. However, it was also important to consider the valence of stimuli, as past research (e.g., Leblond et al., 2016) has indicated it might determine the presence of an SRE and SRRE.

Certain studies have shown that aging is associated with enhanced memory for positive information (i.e., a “positivity bias”; Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005), however not all studies of cognitive aging have supported this theory (Denburg et al., 2003; Grühn et al., 2005; Fernandes et al., 2008; Kensinger et al., 2002; Murphy & Isaacowitz, 2008). There have likewise been mixed results in findings of valence preferences across the lifespan in investigations of the SRE and SRRE. For example, Leshikar et al. (2015) investigated the role of valence in the manifestation of the SRRE in healthy younger and older adult groups, and found that recollection was higher for positive versus negative information *across* age groups. Furthermore, previous studies specifically investigating the influence of self-referential processing on memory for trait adjectives in healthy aging have shown enhanced memory in younger adults for negative items but no difference in valence preference in older adults (Glisky & Marquine, 2009) and similar negative valence preferences across the lifespan (Gutchess et al., 2007, Experiment 2). Carson et al. (2016) is the only study to find a positivity bias specific to healthy older adults in their study of the SRE for trait adjectives, however their investigation of other types of material (narrative information) showed no valence preferences (narrative recognition) and similar negative preferences across the lifespan (narrative recall).

The single study that has examined the influence of valence on the SRE in aMCI (Leblond et al., 2016) found that while healthy older adults exhibited no valence preferences associated with the SRE, individuals with aMCI showed the SRE only for positively valenced trait adjectives. This finding is consistent with other research (not specifically investigating the SRE) that has showed a positivity bias in aMCI (Brueckner & Moritz, 2009; Werheid et al. 2010) but inconsistent with another study which showed a negativity bias in aMCI (Mah et al., 2017). Whether material valence influences the SRE continues to be debated in the literature, and building on this research was a further goal of Experiment 1.

The present study aimed to augment the limited amount of research that has explored the SRE as a strategy for enhancing episodic memory in aMCI and to provide a better understanding of how the SRE exerts its benefits in this population. Given that individuals with aMCI are at high risk for the development of AD (Albert et al., 2011; Petersen et al., 1999; 2001, 2005, 2009), it is critical to understand whether targeted approaches, such as the SRE, can improve episodic memory and thereby slow the progression from aMCI to AD. It was predicted that: (a) those with aMCI would benefit from the SRE but show lower overall memory when compared to healthy counterparts; (b) those with aMCI would show improved recollection for self-related information (i.e., an SRRE) but not to the extent of healthy older adults; and (c) if valence preferences did occur, they would be in the direction of a positivity bias seen exclusively for those with aMCI, as found in previous work on the SRE (Leblond et al.).

Methods

Participants

Twenty older adults with aMCI (age: *M*=72.7, *SD*=5.7) and 30 healthy older adult controls (age: *M*=70.1, *SD*=5.5) participated in the study. All participants completed cognitive testing with a standard battery of neuropsychological tests (described below). Participants were recruited through the Department of Neuropsychology and Cognitive Health at Baycrest Centre and through the Rotman Research Institute and York University research volunteer databases. aMCI was classified according to diagnostic criteria put forth by the National Institute on Aging-Alzheimer's Association (Albert et al., 2011). These included: (1) Cognitive concern reflecting a change in cognition reported by patient, informant, or clinician; (2) Objective evidence of impairment in one or more cognitive domains, including memory; (3) Preservation of independence in functional abilities; and (4) Not demented. All participants received monetary compensation for their participation. The Telephone Interview for Cognitive Status (TICS; Brandt, Spencer, & Folstein, 1988) was administered to participants at the time of recruitment to ensure that general cognitive status was within the "normal" range for study eligibility (cutoff score of 30 points was employed). A brief medical history was also taken over the phone to rule out the presence of neurological (e.g., stroke, traumatic brain injury, neurodegenerative disorders such as Parkinson's disease or Huntington's disease), cardiovascular (e.g., heart attack, cardiac arrest, heart surgery, diabetes) or psychiatric disorders known to affect cognition (e.g., clinical depression). Medical history was again reviewed at the start of the testing session to confirm that none of the exclusionary criteria were met. Informed consent was obtained from all participants in accordance with the procedures of Research Ethics Boards at Baycrest Centre and York University.

Neuropsychological Measures

A brief battery of targeted neuropsychological tests was administered to participants with aMCI and healthy older controls, except in the case that an individual with aMCI had received a neuropsychological assessment in the past 6 months and gave permission for the experimenter to have access to his or her test scores. Neuropsychological testing was conducted in order to confirm study participation group (aMCI or control) and that current mood status (level of self-reported anxiety and depression) was within normal limits. The neuropsychological battery included measures of verbal and non-verbal learning and memory (Hopkins Verbal Learning Test-Revised; Brandt & Benedict, 2001; Brief Visuospatial Memory Test-Revised, Benedict, 1997), working memory (Digit Span; Wechsler, 1997b), processing speed (Digit-Symbol coding; Wechsler, 1997b), incidental memory (Digit-Symbol coding incidental learning; Wechsler, 1997b), word reading (National Adult Reading Test-Revised; Blair & Spreen, 1989), confrontation naming (Boston Naming Test; Kaplan et al., 1983), speed and attention switching (Trail Making Tests A and B; Reitan & Wolfson, 1993), phonemic fluency (FAS; Spreen & Benton, 1977); semantic fluency (animal naming; Rosen, 1980), and an overall screening measure of cognitive functioning (Montreal Cognitive Assessment; Nasreddine et al., 2005). Mood status was measured using the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983).

Trait Adjective Paradigm

Materials. Stimuli were personality trait adjectives rated according to "likeability" (Anderson, 1968). Ninety words with the most positive rankings and ninety with the most negative rankings were randomly assigned to either the study lists or the distractor list that was presented in the recognition task. Nine study lists were created, each comprised of 10 words (five positive, five negative). For the recognition test, the same list of 90 distractor items was presented to all participants, with an equal number of positive and negative words.

Procedure. Participants made yes / no judgments about trait adjective words under three blocked study conditions: self-reference ("Does this word describe me?"), semantic ("Does this word describe a desirable personality trait?"), and structural ("Does this word contain the letter 'e'?"). Trait adjectives were presented on a computer screen using E-Prime software (Psychology Tools), with instructions and paradigm design closely modeled after that employed by Fossati et al. (2003, 2004) and Carson et al. (2016). Three of the nine study lists were assigned to one of the three study conditions, and allocation of list to condition was counterbalanced across participants. Blocked conditions were presented in a pseudorandomized order, with no two blocks of the same condition appearing sequentially. Presentation of each block commenced with an instruction screen indicating which of the three decisions (self-reference, semantic, structural) was to be made for the subsequent presentation of 10 trait adjective words. Each individual trial consisted of a fixation cross presented for 500 ms followed by a trait adjective word presented for 4500 ms, during which time the participant was prompted to make his/her yes/no judgment. This was followed by a 5000 ms fixation cross. Presentation order of words within blocks was randomized across participants. Practice trials preceded the test trials, and response type (yes or no) was recorded for each judgment. A 10-minute retention interval followed the study phase, during which WAIS-III Digit Span, Digit Symbol Coding, Digit Symbol Incidental Learning, and Digit Symbol Free Recall were administered. Following the retention interval, participants were given a recognition test in which they were asked to distinguish previously studied trait adjectives from distractors (old/new button press).

For the recognition test, all 90 studied trait adjectives and 90 distractors were presented in random order, with the same list of distractor items presented to all participants. When a participant indicated that a word had been previously studied ("old"), he or she was then asked to make an additional remember/know decision with a button press. A "remember" button press indicated that the participant was able to recollect specific episodic details from when he or she viewed the trait adjective during the study portion of the paradigm (e.g., any specific thoughts or feelings that were elicited when viewing the trait adjective or contextual elements). A "know" button press indicated that a trait adjective elicited a feeling of familiarity for the participant, but that he or she was unable to relate any episodic or contextual detail with seeing it previously. Participants received a thorough explanation of the remember/know distinction before completing the recognition test and were asked to demonstrate to the examiner that he or she understood the distinction. Participants were also provided with a cue card with a simplified explanation of the remember/know distinction for reference during the recognition test. The recognition test was self-paced and responses were recorded by E-Prime software.

Results

Demographics

See Table 2.1 for demographic information. The aMCI and healthy older adult control groups did not significantly differ in terms of age, $t(48)=-1.62$, $p=.11$ or formal years of education, $t(48)=-.16$, $p=.87$.

Neuropsychological Measures

Performance on neuropsychological measures is presented in Table 2.1. Older adults with aMCI performed significantly worse than their healthy counterparts on tests of episodic learning and memory, both verbal (HVLT-R total: $t(48)=6.7$, $p<.001$, delayed recall: $t(48)=7.2$, $p<.001$, recognition discrimination: $t(48)=6.0$, $p<.001$) and non-verbal (BVMT-R[1] total: $t(40)=5.6$, $p<.001$, delayed recall: $t(40)=7.0$, $p<.001$; Digit Symbol Coding Incidental Learning[2]: $t(47)=4.91$, $p<.001$, Digit Symbol Coding Free Recall: $t(47)=3.3$, $p=.002$). The exception to this was on a test of visual recognition discrimination (BVMT-R), where performance was similar between the groups, $t(40)=1.6$, $p=.12$. This was likely due to the ease of the BVMT-R recognition task, which makes it less sensitive to memory difficulties than the free recall aspect of the test. Performance between the groups did not significantly differ on measures of processing speed (Digit Symbol Coding: $t(48)=.24$, $p=.81$; Trail Making Test A: $t(48)=-9.1$, $p=.37$), working memory (Digit Span Forwards: $t(48)=.76$, $p=.45$; Digit Span Backwards: $t(48)=-.28$, $p=.79$), and executive function (Phonemic Fluency: $t(48)=1.2$, $p=.24$; Trail Making Test B: $t(48)=-1.42$, $p=.16$). The healthy control group showed significantly better performance than the aMCI group on tests of confrontation naming (Boston Naming Test) and semantic fluency (Animal naming) (Boston Naming Test: $t(48)=3.29$, $p=.002$; Animal naming: $t(48)=2.7$, $p=.01$), though the mean scores of the aMCI group on these tests remained in the average range. Self-report of symptoms of anxiety ($t(48)=1.0$, $p=.32$) and depression ($t(48)=.09$, $p=.93$) was similar and within normal limits for both groups. There was no difference in performance between healthy control and aMCI groups on a test of word reading that is correlated with intellectual

[1] Five healthy controls and 3 individuals with aMCI did not complete the BVMT-R as the test was added to the neuropsychological battery after preliminary testing of the study paradigm.
[2] One healthy control did not complete Digit Symbol Coding Incidental Learning and Free Recall due to an administration oversight.

functioning (NART; Blair & Spreen, 1989), $t(48)=.30$, $p=.77$. Lastly, healthy controls significantly outperformed their counterparts with aMCI on the MoCA cognitive screening test ($t(48)=-1.02$, $p=.31$), though the mean score of the aMCI group (25.5) was just below "normal range" (≥26) according to test guidelines (Nasreddine et al., 2005).

Trait Adjective Recognition (SRE)

Trait adjective recognition memory scores were calculated by subtracting the proportion of false alarms (distractor items identified as "old") from the proportion of hits (items identified as "old" that had in fact been studied), creating an overall "corrected recognition" score (uncorrected scores presented in Table 2.2). Each participant had a single false alarm rate across study conditions, as all trait adjectives were tested in the same recognition task. The false alarm rate correction allowed comparisons between aMCI and healthy control groups. The scores of one healthy control participant could not be analyzed due to technical issues during testing.

Corrected recognition results are presented in Figure 2.1. A 2×3×2 (participant group × encoding condition × valence) repeated-measures ANOVA revealed a main effect of condition, $F(2,94)=80.42$, $p<.001$, $\eta_p^2=.63$, with planned contrasts indicating enhanced memory for trait adjectives encoded in the self-reference condition over the semantic condition, $F(1,47)=5.44$, $p=.02$, $\eta_p^2=.10$, and enhanced memory for trait adjectives encoded in the semantic condition over the structural condition, $F(1,47)=82.56$, $p<.001$, $\eta_p^2=.64$. However, a significant group by condition interaction, $F(2,94)=5.98$, $p=.004$, $\eta_p^2=.11$ and follow-up pairwise comparisons indicated that while the healthy older adult group showed enhanced memory for self-referenced trait adjectives over those encoded in the semantic condition ($p<.001$), the aMCI group did not receive extra benefit from engaging in self-referential encoding over semantic encoding ($p=.9$). Both groups showed a benefit of semantic encoding over structural (ps<.001). A main effect of

Table 2.1

Demographic Information and Performance on Neuropsychological Measures

	HC (n=30)	**aMCI (n=20)**	**Effect size (*d*)**
age	70.1 (5.5)	72.7 (5.7)	0.46
education (years)	15.7 (2.8)	15.8 (2.8)	0.04
% female	60	55	
HVLT-R total	28.1 (3.5)	21.6 (3.1) ***	1.96
HVLT-R delayed recall	10.1 (1.6)	6.0 (2.5) ***	1.95
HVLT-R recog disc.	11.4 (.9)	8.7 (2.2) ***	1.60
BVMT-R total	25.2 (5.4)	14.8 (6.4) ***	1.76
BVMT-R delayed recall	10.0 (1.6)	5.4 (2.5) ***	2.19
BVMT-R recog disc.	5.9 (.3)	5.6 (.6)	0.63
Digit Symbol Coding	62.0 (12.6)	61.2 (10.9)	0.07
Incidental Learning	12.3 (4.6)	6.1 (4.0) ***	1.44
Free Recall	7.6 (1.1)	6.2 (1.9) **	0.90
Digit Span Forward	7.0 (1.2)	6.7 (1.2)	0.25
Digit Span Backward	5.23 (1.6)	5.4 (1.3)	0.12
Phonemic Fluency (FAS)	48.2 (10.5)	44.4 (12.0)	0.35
Semantic Fluency (Animals)	20.1 (5.1)	16.1 (5.5) *	0.75
Boston Naming Test	56.6 (2.8)	52.2 (6.5) **	0.88
TMT A (secs)	34.7 (9.8)	37.3 (9.7)	0.27
TMT B (secs)	77.7 (31.4)	90.1 (28.5)	0.41
HADS-A	4.2 (2.8)	5.1 (3.5)	0.28
HADS-D	2.6 (2.6)	2.5 (2.8)	0.04
MoCA	27.7 (2.1)	25.5 (2.4) ***	0.98
NART-R (FSIQ)	116.4 (6.9)	116.0 (4.4)	0.07

Note. Values represent means (standard deviations). HC=healthy controls; aMCI=amnestic Mild Cognitive Impairment; HVLT-R=Hopkins Verbal Learning Test- Revised; recog disc.= recognition discrimination; BVMT-R=Brief Visuospatial Memory Test- Revised; Incidental Learning and Free Recall=memory subtests associated with WAIS-III Digit Symbol Coding test; TMT=Trail Making Test; HADS=Hospital Anxiety and Depression Scale; HADS-A=Anxiety score; HADS-D=Depression score; MoCA=Montreal Cognitive Assessment; NART-R=National Adult Reading Test- Revised; FSIQ=Full Scale Intelligence Quotient. HC significantly higher score than aMCI *** p<.001, ** p<.01, * p<.05.

group indicated that the healthy group showed overall higher corrected recognition than the aMCI group, $F(1,47)=15.22$, $p<.001$, $\eta_p^2=.25$. There was no main effect of valence, $F(1,47)=1.23$, p=.27, $\eta_p^2=.03$ nor a significant valence by group interaction, $F(1,47)=1.1$, p=.3, $\eta_p^2=.02$.

Table 2.2

Trait Adjective Recognition and Recollection "Remember" Scores

			Overall Recognition		**Recollection "Remember" Scores**	
	Condition	**Valence**	**HC**	**aMCI**	**HC**	**aMCI**
Hits	Self-Reference	Pos	.85 (.13)	.83 (.16)	.60 (.31)	.68 (.31)
		Neg	.73 (.19)	.52 (.26)	.45 (.27)	.43 (.28)
	Semantic	Pos	.74 (.18)	.76 (.16)	.47 (.27)	.62 (.27)
		Neg	.62 (.17)	.59 (.23)	.33 (.23)	.46 (.28)
	Structural	Pos	.48 (.22)	.59 (.23)	.26 (.18)	.44 (.27)
		Neg	.36 (.20)	.34 (.17)	.20 (.16)	.25 (.20)
False Alarms		Pos	.35 (.17)	.51 (.17)	.19 (.17)	.39 (.22)
		Neg	.19 (.10)	.27 (.15)	.09 (.09)	.18 (.17)

Note. Values represent means (standard deviations). HC=healthy controls; aMCI=amnestic Mild Cognitive Impairment; Pos=positive; Neg=negative.

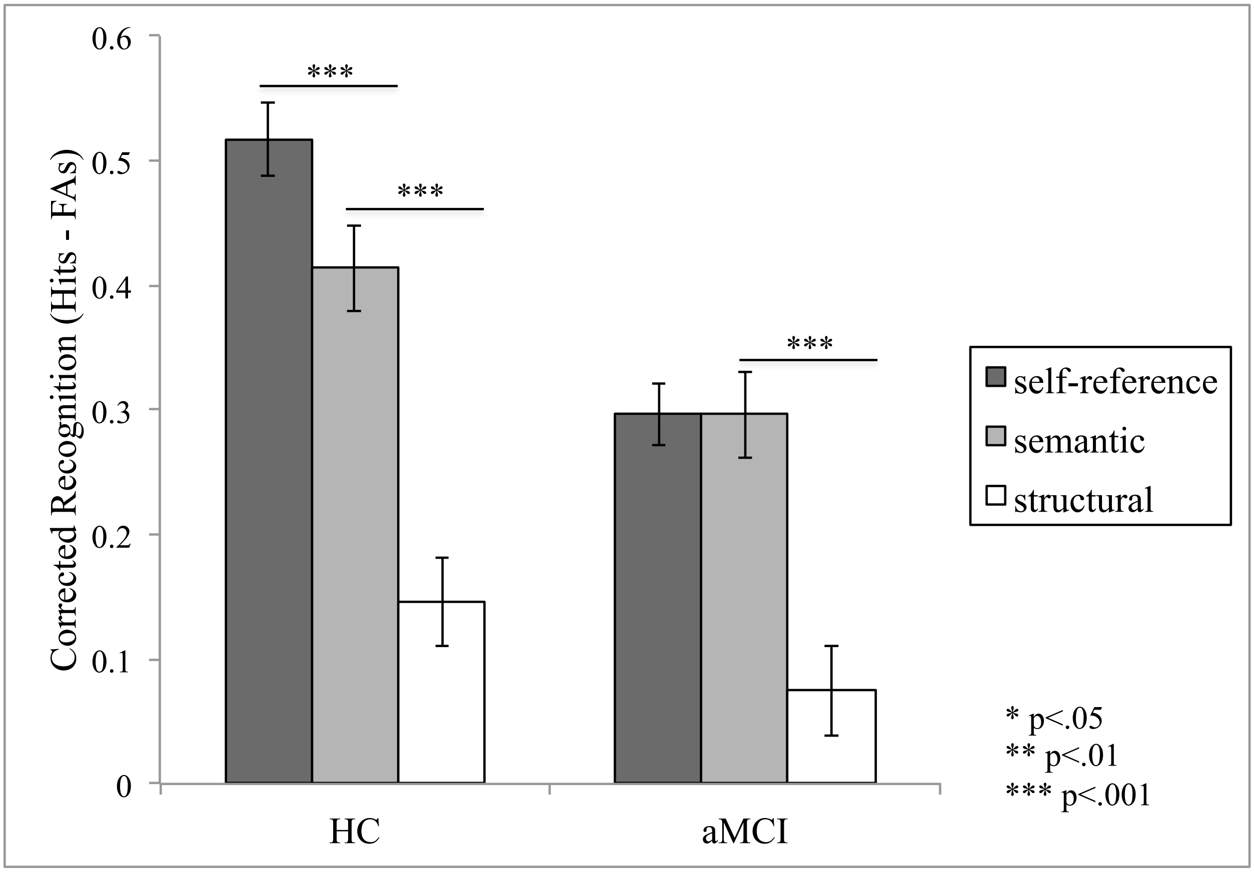

Figure 2.1. Trait adjective corrected recognition scores indicating recognition memory accuracy, as a function of participant group and encoding condition. Error bars represent standard error.

False alarms. Proportion of false alarms (distractor trait adjectives indicated as "old"), presented in Table 2.2, was analyzed in a 2×2 mixed ANOVA (participant group × valence). A main effect of group, $F(1,47)=8.99$, p<.001, $\eta_p^2=.85$ indicated that the aMCI group made significantly more false alarms than the healthy older group. Additionally, a main effect of valence, $F(1,47)=132.24$, $p<.001$, $\eta_p^2=.74$ showed that across both aMCI and healthy control groups, significantly more false alarms were made for positive versus negative trait adjectives. Furthermore, a significant group by valence interaction, $F(1,47)=5.27$, $p=.03$, $\eta_p^2=.10$ indicated a greater difference between positive and negative false alarm scores in the aMCI group (p=.003) than in the healthy control group (p=.03).

Trait Adjective Recollection and Familiarity (SRRE)

Experiences of recollection and familiarity during the recognition test were measured using a remember (recollection)/ know (familiarity) button press. Scores were then calculated with the Independence Remember Know (IRK) method, which holds that recollection and familiarity are independent processes and therefore familiarity should not simply reflect an absence of recollection (Jacoby, Yonelinas, & Jennings, 1997; Yonelinas & Jacoby, 1995). Recollection scores were calculated for each study condition according to corrected recognition [proportion remember hits – proportion remember false alarms]. Familiarity was calculated for each study condition as [proportion of know hits/1-proportion of remember hits] – [proportion know false alarms/1-proportion remember false alarms]. See Table 2.2 for uncorrected scores.

A 2×3×2 (participant group × encoding condition × valence) of recollection scores revealed a main effect of condition, $F(2,94)=60.99$, $p<.001$, $\eta_p^2=.57$, with self-referential encoding enhancing recollection over semantic processing, $F(1,47)=11.46$, $p=.001$, $\eta_p^2=.20$ and semantic processing improving recollection over structural encoding, $F(1,47)=55.19$, $p<.001$, $\eta_p^2=.54$. However, a marginally significant interaction between group and condition, $F(2,94)=2.83$, $p=.06$, $\eta_p^2=.06$ and a closer analysis of the data through pairwise comparisons, indicated that while the healthy older group benefitted from self-referential processing and showed an SRRE (p<.001), the aMCI group did not show a difference in recollection between self-reference and semantic encoding conditions (p=.9). Both groups again showed a significant difference in recollection between the semantic and structural encoding conditions (ps<.001), as depicted in Figure 2.2. There was no significant effect of group, $F(1,47)=2.04$, $p=.16$, $\eta_p^2=.04$, nor were the effects of valence, $F(1,47)=.03$, $p=.86$, $\eta_p^2=.001$ or group by valence interaction significant, $F(1,47)=.97$, $p=.33$, $\eta_p^2=.02$.

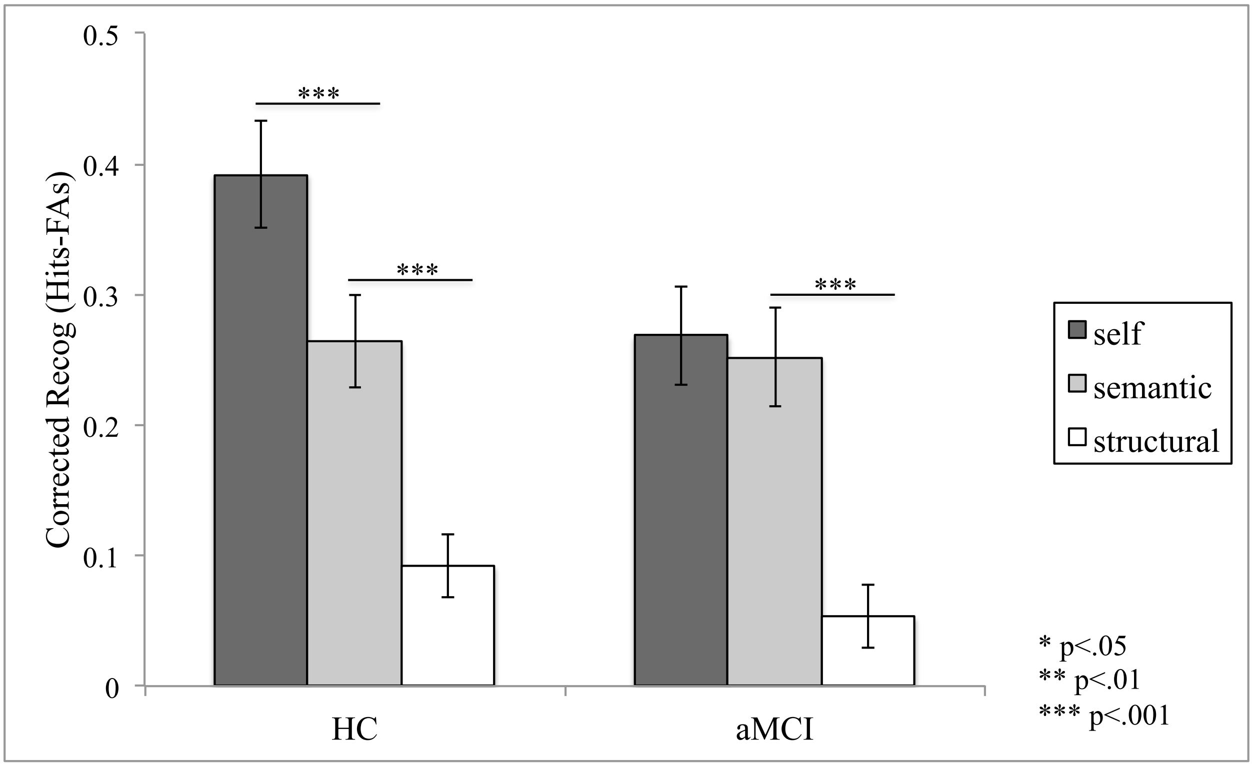

Figure 2.2. Trait adjective corrected recognition, indicating recollection “remember” scores, as a function of participant group and encoding condition. Error bars represent standard error.

The analysis of familiarity scores was limited to a subset of the study participants (12 aMCI and 24 healthy control) as the other participants provided too few “know” button presses to be included in relevant analyses. Mean scores from the remaining sample are shown in Figure 2.3. A 2×3×2 (participant group × encoding condition × valence) of familiarity scores revealed a main effect of group, with healthy controls making more “know” responses for studied material (indicating familiarity) than their aMCI counterparts, $F(1,34)=12.19$, $p=.001$, $\eta_p^2=.26$. There was also a main effect of encoding condition, $F(2,68)=23.57$, $p<.001$, $\eta_p^2=.41$; planned contrasts indicated no difference between familiarity scores in the self-reference and semantic conditions

$F(1,34)$=.87, p=.36, η_p^2=.03 but significantly higher familiarity scores in these conditions compared to the structural condition, $F(1,34)$=29.71, p<.001, η_p^2=.47. A trend towards a significant participant group by encoding condition interaction was revealed, $F(2,68)$=2.67, p=.08, η_p^2=.07, and further investigation indicated that while familiarity scores were significantly different between the self-reference and semantic conditions for the healthy control group (p<.05), the aMCI group showed no significant difference in familiarity scores between these two conditions (p=.77). There was no effect of valence on familiarity scores, $F(2,68)$=.81, p=.38, η_p^2=.02, nor was there a significant group by valence interaction, F(2,68)=.001, p=.97, η_p^2=.001.

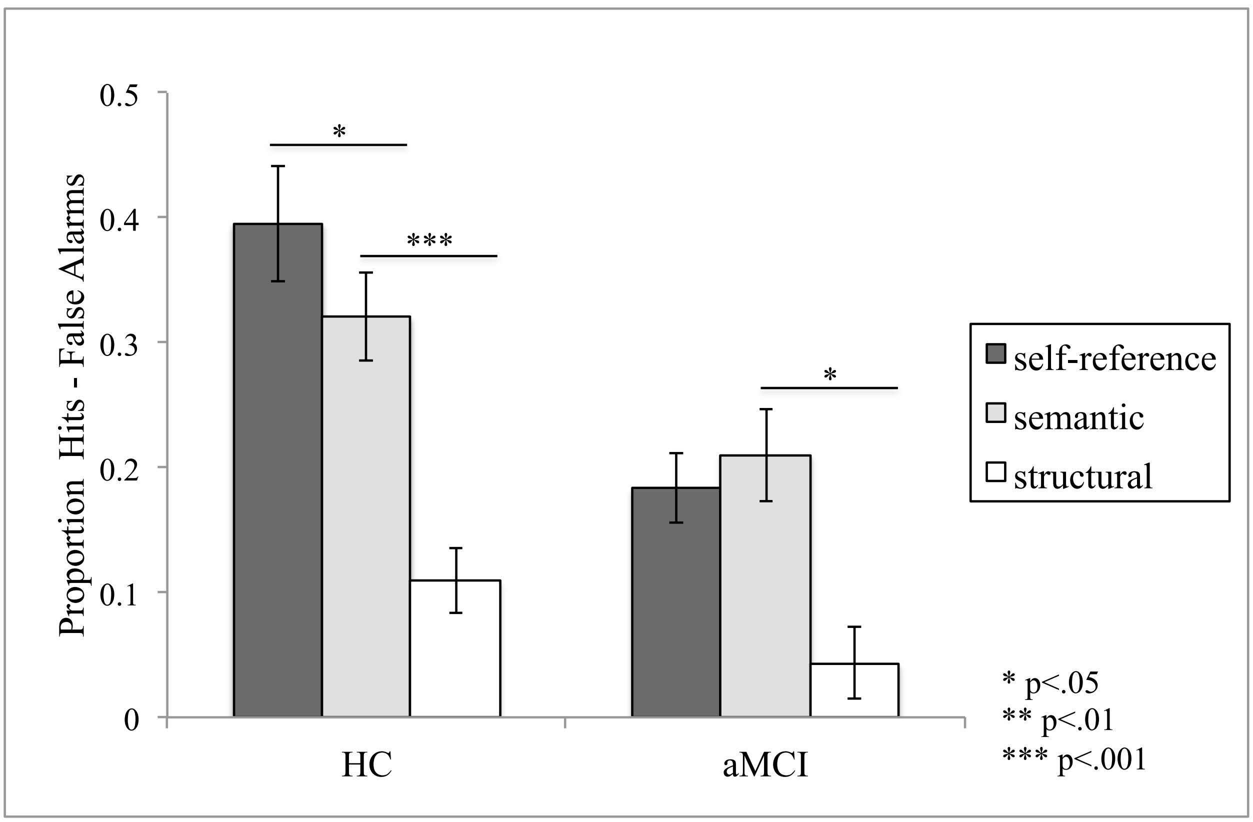

Figure 2.3. Trait adjective familiarity “know” scores, as a function of participant group and encoding condition. Error bars represent standard error.

Discussion

Experiment 1 investigated the robustness of the SRE for trait adjectives in aMCI as well as the mechanisms through which the effect operates in this population. The influence of material valence was also explored. Results indicated that while healthy older adults showed a mnemonic advantage for trait adjectives encoded in the self-reference condition over the semantic condition, individuals with aMCI showed similar benefit for both types of encoding (i.e., an effect of "deep encoding" in general). The SRRE results were similar, showing that while healthy older adults exhibited increased recollection for self-referenced words, individuals with aMCI showed similar levels of recollection for trait adjectives encoded in the self-reference and semantic conditions. No effects of valence were present in either the healthy aging group or the aMCI group. The following is an in-depth discussion of the major findings of this experiment.

The Self-Reference Effect (SRE) for Trait Adjectives in aMCI

To date, two published studies have examined the SRE for trait adjectives in aMCI. Leblond et al. (2016) found that individuals with aMCI showed an SRE for positively valenced trait adjective words, while a study by Rosa et al. (2015) did not find that self-referential processing enhanced memory in aMCI over semantic encoding (this study did not investigate material valence). The results of the current study were more consistent with the findings of the latter of the two studies. Individuals with aMCI did not show a specific benefit to memory for self-referenced words, regardless of word valence. Instead, the present study indicated a general effect of "deep encoding" in aMCI with a similar benefit of self-referential processing and semantic processing on recognition memory relative to structural processing (shallow encoding). Consistent with prior studies, (Carson et al., 2016; Genon et al., 2014; Glisky & Marquine, 2009;

Gutchess et al., 2007; Leblond et al., 2016; Mueller et al., 1986; Rosa et al., 2015) an SRE for trait adjectives was found in the healthy aging control participants.

The current results were inconsistent with those found in the Leblond et al. (2016) study, despite our studies including the same number of individuals with aMCI (n=20), using similar stringent criteria for classifying aMCI, and administering trait adjective SRE paradigms with very similar self-reference and semantic encoding conditions. The trait adjective paradigms used in these two studies were much more similar than that employed in the Rosa et al. (2015) study. Overall memory accuracy (calculated by corrected recognition) for the self-reference and semantic encoding conditions appeared to be higher in the aMCI group in the present study (see Leblond et al., 2016 Figure 2 for comparison). However, even with better overall memory, the SRE pattern did not emerge for the aMCI group in the present study. There were methodological differences between the studies that may have resulted in the absence of an SRE for the aMCI group in our study. First, participants in Leblond et al. encoded 48 trait adjective words in each encoding condition (self-reference, other-reference, semantic) and may have therefore had more of an opportunity to engage in self-referential processing than the participants in the present study, who encoded 30 trait adjective words in each encoding condition (self-reference, semantic, structural). Trait adjectives were also presented differently between the two studies at encoding. In the Leblond et al. study, trials representing the encoding conditions were intermixed, whereas in the present study, trait adjectives were presented according to blocked encoding conditions. The blocked design of the encoding conditions in the present study followed the reasoning of Glisky and Marquine (2009), who stated that requiring older adult participants to switch back and forth between encoding conditions for each trial would impact encoding and also that blocked encoding conditions would help limit carry-over effects of instructions pertaining to different conditions. As mentioned above, the older adults in the present study appeared to show overall higher memory accuracy than those in the Leblond et al. study; thus, the blocked conditions may have been effective in limiting distraction from constantly changing encoding demands, thereby promoting overall memory. Despite presenting trait adjectives in blocked encoding conditions, carry-over effects of the encoding instructions may have still been a concern in the present study and possibly account for the similar performance for self-reference and semantic conditions in the aMCI group. However, this is unlikely given that the examiner emphasized the different instructions for each encoding condition throughout the study portion of the paradigm and also given that carry-over effects do not seem to have influenced performance in the structural condition.

There are additional methodological differences between the present study and that of Leblond et al. (2016), which may account for the disparate results. For example, during the recognition test of the Leblond et al. study, only a portion of the studied trait adjectives (84/144) were presented, intermixed with 30 distractors. The recognition test employed in the present study was likely more cumbersome, as it included all 90 of the studied trait adjectives intermixed with 90 distractors. Perhaps the recognition format of the current study was intimidating to those with aMCI and required too much of a cognitive load for the SRE to be of much benefit at retrieval. The present study also included a 10-min retention interval between encoding and recognition, during which participants completed distraction tasks, whereas the Leblond et al. study tested recognition immediately following encoding. This raises the possibility that the aMCI group tested in the present study was unable to maintain benefits from self-referential processing after being presenting with distracting information over a 10-minute interval. Conversely, this also raises the possibility that the SRE evident in the Leblond et al. study may not persist past a few minutes. Finally, participants in the Leblond et al. study completed the encoding and recognition portions of their experiment from within an MRI scanner. Anxiety associated with this environment may have influenced their lower memory accuracy when compared to the performance of our aMCI participants, though it does not explain why the SRE was found in their sample and not in the present experiment.

An alternative to attempting to explain why the aMCI sample did not show the same SRE pattern as the one found in Leblond et al. (2016) is to consider that perhaps those with aMCI do not generally benefit from self-referential processing over and above that of semantic processing. Though some studies show that personal semantic memory remains relatively intact in MCI (Barnabe et al., 2012; Gamboz, et al., 2010; Murphy et al., 2008) others indicate a decline in this ability (Leyhe et al., 2009; Irish et al., 2010). Perhaps the inability of participants with aMCI in our study to benefit from self-referential processing over and above that of general semantic processing provides support for the decline of personal semantic memory in aMCI. The self-reference component of the trait adjective paradigm employed in the current study relies on self-knowledge, which is perhaps not as easily accessible in aMCI as it is in healthy cognitive aging. It is notable that the results of the present study are consistent with those of Rosa et al. (2015); who likewise found no significant difference in memory between self-reference and semantic conditions for individuals with aMCI.

The present study showed that the aMCI group benefited from deep encoding in general, which has not necessarily been the case in studies of the SRE in AD. Lalanne et al. (2013) specifically compared depth of processing effects in AD and found that regardless of whether information was encoded in self-reference or semantic conditions, memory was not improved over a baseline perceptual condition (which provided shallow encoding). Genon et al. (2014), who likewise found no significant difference between self-reference and other-reference conditions in AD, did not include a shallow encoding condition, making it unclear as to whether those with AD benefited from deep encoding in their study. Furthermore, a study by Froger et al. (2009) indicated that the amount by which those with aMCI benefit from deep encoding differs according to the level of retrieval support provided at recognition. In their study, the aMCI group benefitted from semantic encoding similarly to healthy young and older participants on a test of recognition, but did not maintain this benefit on a test of free recall.

Influence of Valence

While those with aMCI in the Leblond et al. (2016) study showed the SRE, the effect was only present for positively valenced trait adjectives. This finding is consistent with some of the limited research conducted on emotional valence specifically in aMCI, indicating that this population shows a positivity bias in memory (Brueckner & Moritz, 2009; Werheid et al. 2010), however inconsistent with another study that showed a negativity bias in aMCI (Mah et al., 2017). Material valence had an important impact on the presence of the SRE in the Leblond et al. (2016) study, however the aMCI group in the present study showed no influence of valence on memory for trait adjective words. The healthy control group in the present study likewise showed no influence of item valence on memory, consistent with some of the studies that have investigated the SRE in healthy older adults (Carson et al., 2016, Experiment 2; Glisky & Marquine, 2009; Gutchess et al., 2007, Experiment 3; Leblond et al., 2016) but inconsistent with socioemotional selectivity theory, which predicts greater attention to positive material in older age (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005).

One area where a notable positivity bias was indeed found for both the healthy control group and aMCI group in the present study was in terms of false alarms made on the recognition test. Participants across both groups were more prone to make false alarms for positively valenced words, and this finding is consistent with other studies of the SRE in healthy aging and aMCI (Gutchess et al., 2007; Glisky & Marquine, 2009; Leblond et al., 2016). Glisky and Marquine (2009) attributed these findings to evidence that positive information is remembered in a more gist-like, general fashion (see Kensinger, Garoff-Eaton, & Schacter, 2007), making it more difficult to distinguish between studied and distractor items. Though participants in the current study did not show a memory bias for positively valenced trait adjectives, both healthy controls and those with aMCI did show an inclination towards positively valenced distractor stimuli.

The Self-Reference Recollection Effect (SRRE) in aMCI

The present study is the first to investigate the SRRE in aMCI. The results indicated that self-referential processing did not provide an additional benefit to recollection in aMCI over and above that gained from semantic processing. This is in comparison to healthy older adult controls, who indeed showed a unique benefit to recollection for self-referenced trait adjectives. Interestingly, the aMCI group and healthy controls showed similar overall levels of recollection, though the healthy controls benefited from the SRRE. Given that aMCI is a transition state between healthy cognitive aging and AD, and populations on both ends of the spectrum have been shown to exhibit the SRRE (Carson et al., 2016; Genon et al., 2014; Kalenzaga & Clarys, 2013; Kalenzaga et al., 2013; Lalanne et al., 2013; Leshikar et al., 2015; albeit an influence of valence in AD), it was surprising not to find an SRRE in our aMCI group. Furthermore, where studies of the SRRE in AD indicated an interaction between the SRRE and valence of material (SRRE for negative material in Kalenzaga & Clarys, 2013 and Kalenzaga et al., 2013; SRRE for positive material in Lalanne et al., 2013), the present study showed no significant effect of valence.

Methodological differences may underlie the disparate results found in our study compared to others, particularly studies of the SRRE in AD. One important difference is the way that recollection scores were calculated. The present study calculated recollection scores by correcting for false alarms (as in Genon et al., 2014; Leshikar et al; 2015), whereas other studies of the SRRE in AD (Kalenzaga & Clarys, 2013; Kalenzaga et al., 2013; Lalanne et al., 2013) did not correct for false alarms. As discussed for the SRE in Leblond et al. (2016), failing to correct for false alarms can lead to important misinterpretations of data.

It is also difficult to ascertain whether, similar to the aMCI group in the present study, healthy older adults and AD patients tested in other studies show an effect of deep encoding in addition to the SRRE, as few of them included shallow encoding conditions. Lalanne et al. (2013) was the only study to include a shallow perceptual encoding condition and found a depth of processing effect for healthy older adults but not for individuals with AD. Similar to the healthy older adult group of this study, the aMCI group of the present study showed improved recollection with deep encoding in general, however, as mentioned above, this may not be an appropriate comparison given that the two studies calculated recollection using different methods.

Though familiarity scores could only be analyzed for a subset of participants in the present study, results indicated a similar pattern to the analyses of corrected recognition and recollection, with healthy older adults showing higher familiarity scores overall and a benefit of self-related processing to familiarity, and the aMCI group showing no difference between scores in the self-reference and semantic conditions. Familiarity scores were higher than in the structural condition, however, indicating that familiarity also benefited from deep encoding in aMCI. There was no influence of valence on familiarity scores. Familiarity processes have generally been shown to be less affected in aMCI than recollection (Anderson et al., 2008; Hudon et al., 2009; Irish et al., 2010; Serra et al., 2010; Westerberg et al., 2006), though some studies have produced contradictory results, such that familiarity also declines (Ally et al., 2009; Koen & Yonelinas, 2014; Wolk et al., 2008). It is therefore encouraging that deep encoding in general can enhance familiarity processes in aMCI.

Conclusions

The present study is the first to investigate the contributions of recollection and familiarity to memory for self-related material (i.e., the SRRE) in aMCI and one of few to examine the benefits of the SRE strategy in this population. Using a trait adjective paradigm, the results of the current study indicate that while episodic memory in healthy older adults benefits from the SRE, there is a more general effect of deep encoding on memory in aMCI, with a similar effect of self-referential and semantic processing. Furthermore, there were no effects of valence associated with the SRE, except for higher false alarms for positive trait adjectives in both healthy controls and aMCI. The present study also indicated that both recollection and familiarity are enhanced in aMCI by deep encoding: both processes improved to a similar extent with self-referential and semantic encoding over and above shallow, structural encoding. This finding suggests that, unlike their healthy counterparts, those with aMCI do not show an SRRE for trait adjectives. It is nonetheless encouraging that episodic memory and recollection, both known to decline in aMCI, can be improved with deep encoding strategies generally. These findings are especially important to consider in the design of memory intervention programs for aMCI.

CHAPTER 3

Experiment 2: The SRE for Narrative Information in Healthy Aging and aMCI

Experiment 1 indicated that individuals with aMCI do not benefit from the SRE over and above that of semantic encoding for trait adjective material. A similar pattern was found for recollection, with no SRRE found in the aMCI group, but equivalent levels of recollection for trait adjectives encoded in self-reference and semantic conditions. This is in comparison to healthy older adults, who showed both an SRE and SRRE for trait adjective words. In Experiment 1, neither individuals with aMCI nor healthy older adult controls exhibited an influence of valence on memory for trait adjectives. The primary goal of Experiment 2 was to investigate the SRE and SRRE for meaningful communication, narrative information, in aMCI. Potential effects of valence on memory for narrative information were also explored.

As mentioned above, the majority of studies administer trait adjective paradigms to investigate the SRE, similar to the one administered in Experiment 1. However, trait adjective words are unlikely to simulate real-world demands on memory. Narrative material engages different and richer processes than single words (Xu et al., 2005) and neuroimaging studies show that distinct brain regions are implicated in lab-based tests of episodic memory involving recognition of single words versus real-world tests of autobiographical episodic memory involving recall of personal narratives (e.g., Gilboa, 2004; McDermott, Szpunar, & Christ, 2009). The incorporation of complex and meaningful narrative material as stimuli provides a more ecologically valid approach to investigating the utility of the SRE for enhancing memory in healthy aging and aMCI. Perhaps those with aMCI would benefit from the SRE when to-be-remembered information is meaningful, contextual, and has real-world importance, such as narrative information.

Memory for narrative information is integral to everyday functioning as it characterizes communications of our own life experiences and allows us to gather knowledge about others (Kropf & Tandy, 1998). We communicate in everyday life in a manner that resembles storytelling (Miller, 1995). The integration of personal narratives has been thought to influence the overall coherence of self-identity (Mar, Peskin, & Fon, 2010) and the maintenance of a coherent sense of self through time (Bluck & Habermas, 2000; Tulving, 2002). Memory for narrative information in older age is not only crucial for communication but also for gathering information about the world, in order to inform future decision making, through reading newspapers and books and listening to news programs on the radio and television (Johnson et al., 2003). Though memory for narrative information plays an important role in maintenance of a sense of self and future planning, previous research demonstrates that individuals with aMCI show reduced memory for narrative information compared to their healthy aging peers (e.g., Belleville et al., 2006; Cunje et al., 2007; Hua et al., 2008; Nordlund et al., 2005; Wang & Zhou, 2002).

There are few studies that have investigated the SRE for narrative information in either healthy individuals or in those experiencing memory disorders. An early study by Reeder, McCormick, and Esselman (1987) showed that memory for personality profiles is enhanced when self-referential processing is emphasized during reading. Carson et al. (2016) found that the SRE improved cued recall and recognition memory of narrative information in healthy young and older adults. In one of few studies of memory-disordered populations, Grilli and Glisky (2010) found that self-referencing is an important component in promoting recognition of narrative information in individuals with traumatic brain injury. In a more recent study, Grilli et al. (2017) found equal benefit of the SRE for narrative information in cognitively intact older adults at greater risk for developing AD due to being carriers of the ε4 polymorphism of apolipoprotein E (APOE) and in those who are not carriers. Drawing on successful use of the SRE strategy for narrative information in healthy aging and in memory-impaired populations, the present study aimed to investigate whether the SRE enhances narrative memory in aMCI.

Experiment 1 of the current dissertation indicated that individuals with aMCI do not show a benefit to recollection with self-referential processing over and above that of semantic encoding. This was the first study to explore the SRRE in aMCI. Perhaps the nature of the to-be-remembered information influences the ability of those with aMCI to show the SRRE. The current experiment further examined whether self-referential encoding would improve recollection in aMCI for narrative information, which is more meaningful and ecologically valid than single trait adjective words.

Another factor that may influence the SRE is the valence of the study material. The effect of valence on memory in aging remains a debated issue in the literature. While some studies find a "positivity bias" in aging consistent with sociemotional selectivity theory (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005), others do not (e.g., Denburg et al., 2003; Grühn, Smith, & Baltes, 2005; Fernandes, Ross, Wiegand, & Schryer, 2008; Kensinger et al., 2002; Murphy & Isaacowitz, 2008). Experiment 1 indicated no influence of valence on the SRE for either individuals with aMCI or healthy controls for trait adjectives. Since one of few published studies of the SRE in aMCI found an effect specifically for positive trait adjectives (Leblond et al., 2016), the jury is still out as to whether the SRE in aMCI is influenced by valence. Furthermore, such an effect may differ depending on the meaningfulness of the information that is encoded. The current study therefore aimed to build on past research by investigating the effect of valence on the SRE for narrative information in aMCI. Predictions for Experiment 2 included: (a) individuals with aMCI would benefit from the SRE for narrative memory but likely show lower overall memory when compared to healthy counterparts; (b) those with aMCI would show improved recollection for self-related information (i.e. an SRRE) but not to the extent of healthy older adults; (c) if there proved to be an effect of valence on the SRE in aMCI, it would be in the direction of a positivity bias, however it is also possible that no effect of valence would be found for either individuals with aMCI or healthy older adult controls.

Methods

Participants

Participants were the same individuals tested in Experiment 1. Twenty older adults with aMCI (age: M=72.7, SD=5.7) and 30 healthy older adult controls (age: M=70.1, SD=5.5) participated in the study. See Experiment 1, pg. 26 for further detail.

Narrative Paradigm

A narrative paradigm was administered to investigate whether those with aMCI showed an SRE, an SRRE, and whether there were any valence preferences associated with memory for narrative information.

Materials. Narratives presented in the study phase were those generated for a study by Carson et al. (2016). The narratives were equated according to the number and type of event details using the Autobiographical Interview scoring method (Levine et al., 2002). Each narrative contained exclusively internal details – episodic details that specifically related to the event described in the story. Narratives were written from the first-person perspective and described either a positive or negative experience, including perceptual elements and thoughts and feelings of the protagonist. See Figure 3.1 for an example. In a pilot session, narratives were rated in terms of ease of comprehension, emotional valence, identification with the protagonist, and ease of visualization (as in Fotopoulou, Conway, Solms, Tyrer, & Kopelman, 2008). Ten healthy young and ten healthy older adults participated in the piloting of the narratives. Participants rated 60 narratives (30 positive, 30 negative) on the aforementioned criteria. Study material included 18 positive and 18 negative narratives, chosen based on their similarity in ratings. Another 18 narratives (9 positive, 9 negative) were allocated as "distractor" narratives to be presented during the recognition test. Another 18 narratives (9 positive, 9 negative) were then generated with similar themes as the narratives that would be studied, but with different content. These were also used as distractors during the recognition test.

Each of the studied narratives was three to four sentences in length (46 to 53 words); half of the narratives described a positive event, and the other half a negative event. Each narrative was presented with a corresponding title. Reading ease and grade level of narratives were analyzed using Microsoft Word 2007 Readability Statistics, and positive and negative narratives did not differ on these dimensions (Flesch Reading Ease: M=77.8, SD=7.5; Flesch–Kincaid Grade Level: M=5.9, SD=1.2[3]). Narratives were randomly assigned to six study lists of six narratives each (three positive and three negative per list) and one distractor list of 36 narratives (half positive, half negative).

[3] The Flesch Reading Ease is scored out of 100, with higher scores representing ease of reading a text. The Flesch-Kincaid Grade Level indicates the American grade level thought to be necessary for the comprehension of the text.

New Baby

event **time** **perceptual** **perceptual**
My cousin gave birth to a baby girl on Mother's Day. She was so tiny and her skin was pink.

thought/emotion **thought/emotion**
I was nervous about the delivery, so I was thrilled upon hearing that both the baby and mother

event
were doing well. I immediately went to visit them.

Figure 3.1. Generation of narratives according to internal detail categories described in the Autobiographical Interview scoring protocol (Levine et al., 2002).

Procedure. Participants made yes / no judgments about narratives under three blocked study conditions, self-reference, semantic, and structural. Each block of self-reference condition trials began with an instruction screen stating, "As you read the following stories, imagine that you are the person who actually experienced the event and is telling the story. Ask yourself, 'Can I easily imagine myself experiencing this event?' Press the yellow button for 'yes' and the blue button for 'no'." Subsequently, during each self-reference condition trial, participants were presented with a narrative and the prompt, "Easy to imagine myself?" for which they were asked to make a yes/no button press. Each block of semantic condition trials began with an instruction screen stating, "As you read the following stories, think about the event being described. Ask yourself, 'Does this story describe a positive event?' Press the yellow button for 'yes' or the blue button for 'no'." Subsequently, during each semantic condition trial, participants were presented with a narrative and the prompt, "Positive event?" for which they were asked to make a yes/no button press. Each block of structural condition trials began with an instruction screen stating, "As you read the following stories, count the number of times the word 'the' appears. Ask yourself, 'Does the word 'the' appear more than 3 times?' Press the yellow button for 'yes' and the blue button for ‘no’.” Subsequently, during each structural condition trial, participants were presented with a narrative and the prompt, “‘The’ more than 3 times?” for which they were asked to make a yes/no button press. Narratives were presented on a computer screen with E-Prime software (Psychology Tools). Each of the six study lists was assigned to either the self-reference, semantic, or structural study condition (two lists per condition), and the assignment of list to condition was counterbalanced across participants. Blocked conditions were presented in a pseudorandomized order, with no two blocks of the same condition appearing sequentially. Presentation of each block commenced with an instruction screen that that informed the participant of the judgment they were going to be asked to make (self-reference, semantic, or structural) for the subsequent six narrative trials. Each individual trial began with a fixation cross presented for 500 ms followed by a narrative presented for 20 sec[4], during which time the participant was prompted to make the yes/no judgment. Each trial ended with the presentation of a fixation cross for 5 sec. Presentation order of narratives within a given block was randomized across participants. Practice trials preceded test trials. Reaction time and response type (yes/no) was recorded for each judgment. During a 10-minute retention interval, participants were administered the National Adult Reading Test-Revised (NART-R) and a subtraction task devised by the investigators.

Following the retention interval, a cued recall test was administered, during which participants were asked to recall as many details as possible aloud from each narrative, with the narrative’s title serving as a cue. A recognition test was subsequently administered, and asked participants to distinguish previously studied narrative details from distractor details (old/new button press). For the recognition test, 36 studied narratives details and 36 distractor details were presented in random order. Half of the distractor details had a similar theme to studied narrative

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[4] The duration for which narratives were presented was determined by pilot testing for Carson et al. (2016).

details and half had novel themes. See Figure 3.2 for examples. An equal number of positive and negative distractor details were presented. When a participant indicated that a narrative detail had been previously studied ("old"), he/she was asked to make an additional remember/know decision with a button press. Participants received a thorough explanation of the remember/know distinction before completing the recognition test and were asked to demonstrate to the examiner that they understood this distinction. Participants were also given a cue card with a simplified explanation of the remember/know distinction for use during the recognition test. The recognition test was self-paced, and responses were recorded.

Original Narrative Presented During Study
My cousin gave birth to a baby girl on Mother's Day. She was so tiny and her skin was pink. I was nervous about the delivery, so I was thrilled upon hearing that both the baby and mother were doing well. I immediately went to visit them.

Corresponding Detail Presented During Recognition Test
I was thrilled upon hearing that both the baby and mother were doing well.

Distractor Detail Presented During Recognition Test (same theme)
I was really surprised to suddenly have a baby brother.

Distractor Detail Presented During Recognition Test (novel theme)
I was proud at the acknowledgment of my hard work.

Figure 3.2. Examples of a narrative presented during study, the corresponding detail presented at recognition, a distractor detail with the same theme presented at recognition, and a distractor detail with a novel theme presented at recognition.

Scoring of narrative cued recall test. Narrative cued recall was scored according to a scoring key created for each narrative in order to standardize scoring between raters. An example of the narrative cued recall scoring protocol is presented in Figure 3.3. Details were accepted if they had the same or equivalent meaning to narrative components (as in Fotopoulou et al., 2008). Details were then tallied according to the condition and valence in which they were initially presented. This allowed comparison of overall recall for narrative information between the three encoding conditions and two valence conditions. Scoring was performed by two independent raters, blind to the allocation of narratives to the study conditions. Inter-rater reliability was calculated using Pearson's correlation coefficient.

New Baby

Element from story	**For point**
1) My cousin **gave birth** to a baby girl	or had a baby
2) on **Mother's Day**	
3) She was so **tiny**	or small
4) and her **skin was pink**	
5) I was **nervous** about the delivery	or anxious, fearful, apprehensive, scared about the delivery
6) so I was **thrilled** upon hearing that both the baby and mother were doing well	happy that everything went well
7) I immediately **went to visit them**	

Figure 3.3. Example of narrative cued recall scoring protocol.

Results

Participant Demographics and Neuropsychological Measures

Participant demographics and performance on neuropsychological measures are presented under Experiment, Table 2.1. The aMCI and healthy older adult control groups did not significantly differ in terms of age, $t(48)=-1.62$, p=.11 or formal years of education, $t(48)=-.16$, p=.87.

Narrative Cued Recall (SRE)

Raters showed high inter-rater reliability with a Pearson's correlation coefficient of 0.96.

A 2×3×2 (participant group × encoding condition × valence) repeated-measures ANOVA revealed a main effect of group, indicating that the healthy group showed higher recall of narrative details than the aMCI group, $F(1,48)=25.23$, $p<.001$, $\eta_p^2=.35$. A main effect of condition was found, $F(2,96)=38.05$, $p<.001$, $\eta_p^2=.44$, with planned contrasts indicating enhanced memory for narratives encoded in the self-reference condition over the semantic condition, $F(1,48)=4.9$, $p=.03$, $\eta_p^2=.09$, and enhanced memory for narratives encoded in the semantic condition over the structural condition, $F(1,48)=31.57$, $p<.001$, $\eta_p^2=.40$. However, a marginally significant interaction between participant group and encoding condition, $F(2,96)=2.63$, $p=.08$, $\eta_p^2=.05$, and follow-up pairwise comparisons, revealed that while there was a significant difference between the self-reference and semantic conditions for healthy controls ($p=.02$), this difference was not significant for the aMCI group ($p=.99$). Both groups showed a significant advantage for the semantic condition over the structural condition (ps<.001). A main effect of valence, indicating better recall for negative details over positive details was revealed, $F(1,48)=50.69$, p<.001, $\eta_p^2=.51$. The interaction between participant group and valence was non-significant, $F(1,48)=.08$, p=.78, $\eta_p^2=.002$. A significant interaction between encoding condition and valence, $F(1,48)=3.36$, $p=.04$, $\eta_p^2=.07$, and pairwise comparisons, indicated that while there was no significant difference in performance between self-reference and semantic conditions for positive narrative details ($p=.85$), there was a significant advantage for the self-reference over semantic condition for negative details ($p=.04$). Regardless of valence, details encoded through the semantic condition showed better recall than those in the structural condition (ps<.001). See Figure 3.4 for cued recall performance.

Narrative Recognition (SRE)

Narrative recognition scores were calculated by subtracting the proportion of false alarms from the proportion of hits, resulting in a "corrected recognition" score. Each participant had a single false alarm rate across study conditions, as memory for all narrative details were tested in one recognition task. The false alarm rate correction allowed comparisons between aMCI and healthy control groups. See Table 3.1 for uncorrected scores.

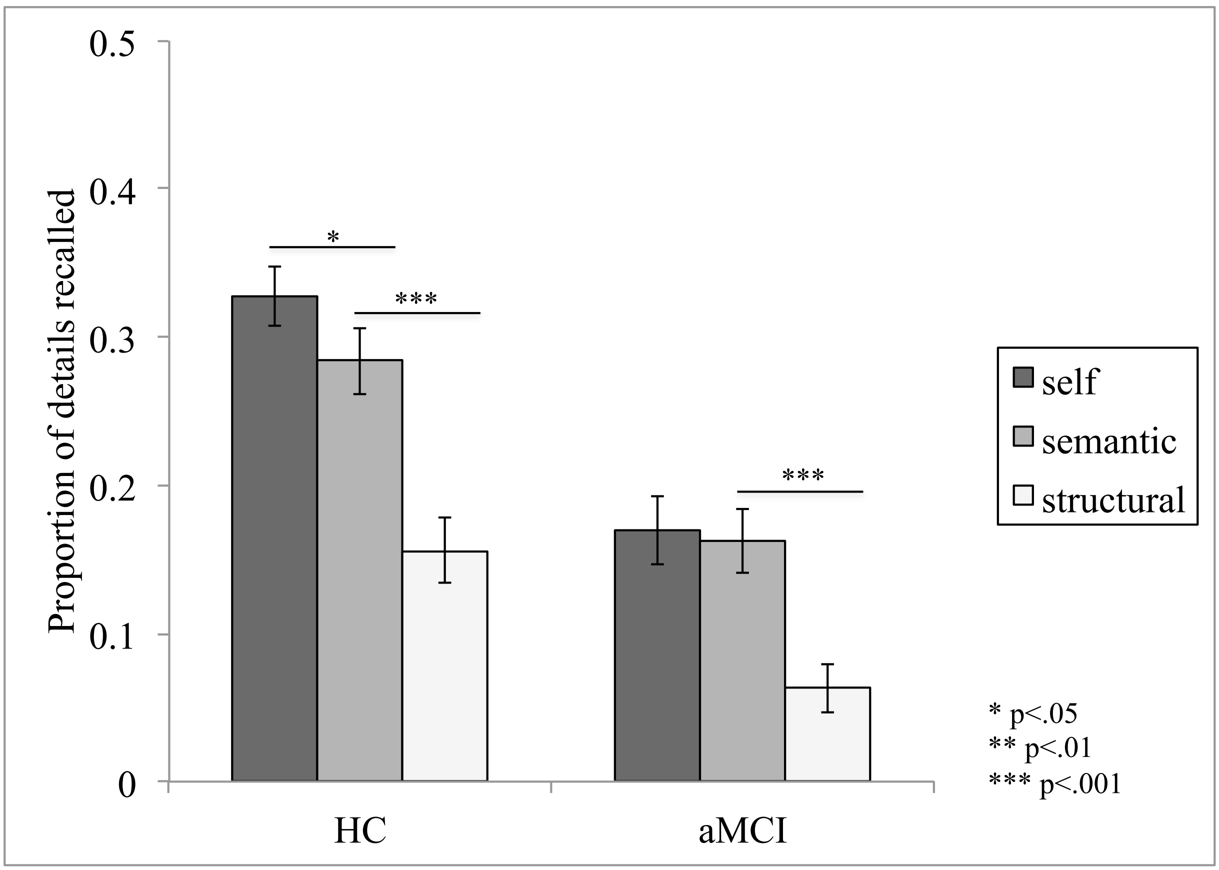

Figure 3.4. Narrative cued recall scores, as a function of participant group and encoding condition. HC=healthy control; aMCI=amnestic Mild Cognitive Impairment. Error bars represent standard error.

Table 3.1
Narrative Recognition and Recollection "Remember" Scores

	Condition	Valence	Overall Recognition HC	Overall Recognition aMCI	Recollection "Remember" Scores HC	Recollection "Remember" Scores aMCI
Hits	Self-Reference	Pos	.87 (.13)	.81 (.16)	.68 (.27)	.65 (.22)
		Neg	.88 (.14)	.70 (.19)	.72 (.27)	.61 (.25)
	Semantic	Pos	.82 (.16)	.72 (.22)	.63 (.31)	.60 (.29)
		Neg	.83 (.14)	.66 (.20)	.59 (.29)	.52 (.32)
	Structural	Pos	.44 (.27)	.38 (.27)	.24 (.27)	.25 (.23)
		Neg	.49 (.27)	.39 (.26)	.32 (.28)	.28 (.27)
False Alarms		Pos	.10 (.08)	.16 (.17)	.04 (.05)	.09 (.13)
		Neg	.08 (.07)	.13 (.12)	.03 (.04)	.09 (.11)

Note. Values represent means (standard deviations). HC=healthy controls; aMCI=amnestic Mild Cognitive Impairment; Pos=positive; Neg=negative.

A 2×3×2 (participant group × encoding condition × valence) repeated-measures ANOVA revealed a main effect of group, indicating that the healthy group showed overall higher corrected recognition than the aMCI group, $F(1,48)=15.03$, $p<.001$, $\eta_p^2=.24$. A main effect of condition, $F(2,96)=103.04$, $p<.001$, $\eta_p^2=.68$, with planned contrasts indicating enhanced memory for narratives encoded in the self-reference condition over the semantic condition, $F(1,48)=9.39$, $p=.004$, $\eta_p^2=.16$, and enhanced memory for narratives encoded in the semantic condition over the structural condition, $F(1,48)=108.22$, $p<.001$, $\eta_p^2=.69$. There was no significant interaction between participant group and encoding condition, $F(2,96)=49$, p=.62, $\eta_p^2=.01$. No main effect of valence was revealed, $F(1,48)=.21$, p=.65, $\eta_p^2=.004$ nor a significant valence by group interaction, $F(1,48)=1.51$, p=.23, $\eta_p^2=.03$. See Figure 3.5 for corrected recognition performance.

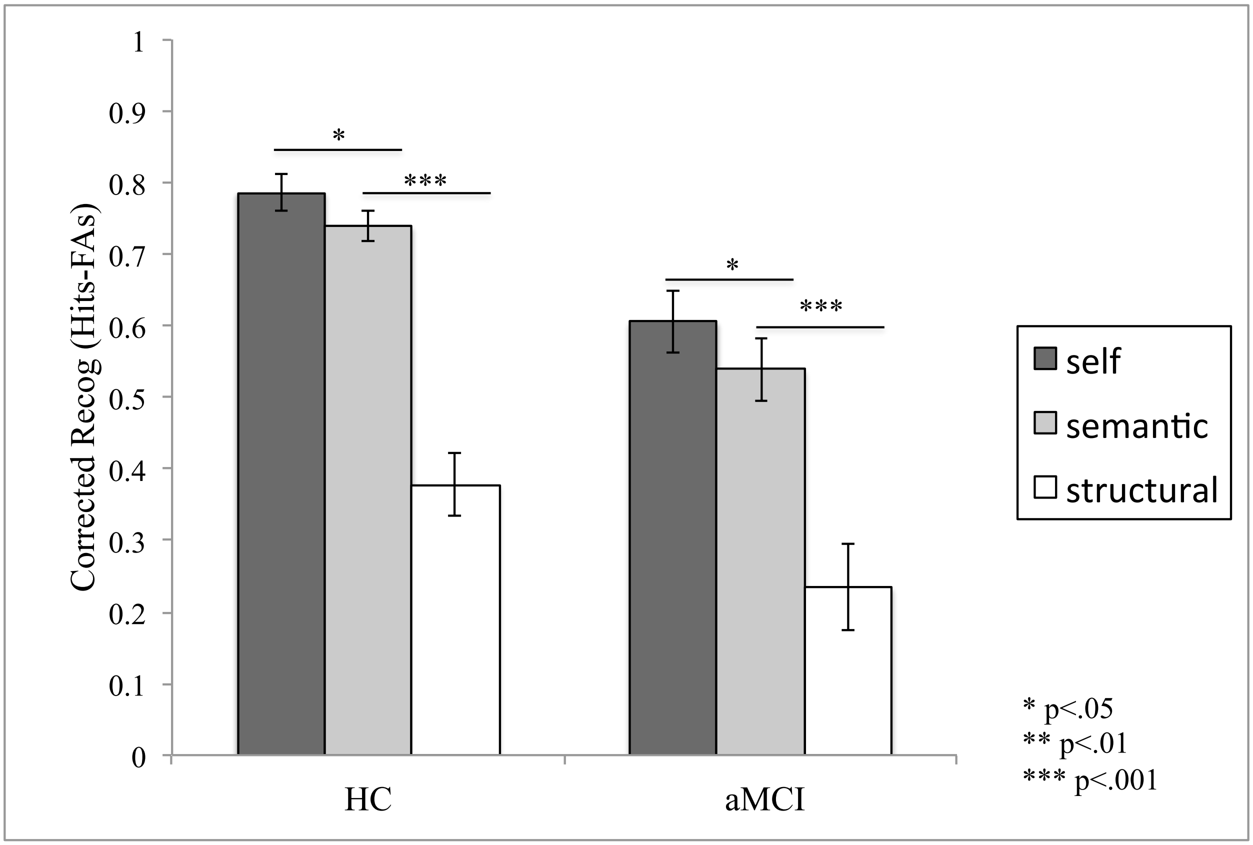

Figure 3.5. Narrative corrected recognition scores indicating recognition memory accuracy, as a function of participant group and encoding condition. Error bars represent standard error.

False alarms. Scores are presented in Table 3.1. Proportion of false alarms (distractor narrative details endorsed as "old") was analyzed in a 2×2 mixed ANOVA (participant group × valence). A main effect of group, $F(1,48)=4.45$, $p<.04$, $\eta_p^2=.09$ indicated that the aMCI group made significantly more false alarms than the healthy older group. Additionally, a main effect of valence, $F(1,48)=4.57$, $p=.04$, $\eta_p^2=.09$ showed that across both aMCI and healthy control groups, significantly more false alarms were made for positive versus negative narrative details. A significant group by valence interaction was not revealed, $F(1,48)=.18$, $p=.67$, $\eta_p^2=.004$.

Narrative Recollection (SRRE)

Experiences of recollection and familiarity during the recognition test was measured using a remember (recollection)/ know (familiarity) button press. Scores were then calculated with the Independence Remember Know (IRK) method (Jacoby, Yonelinas, & Jennings, 1997; Yonelinas & Jacoby, 1995). Recollection scores were calculated for each study condition according to corrected recognition [proportion remember hits – proportion remember false alarms]. See Table 3.1 for uncorrected scores. There were few "know" button presses made indicating Familiarity across both participant groups and this prevented further analysis of familiarity scores. Though unfortunate, this did not impede the main goal of studying recollection in healthy aging and aMCI.

A 2×3×2 (participant group × encoding condition × valence) of recollection scores revealed a main effect of condition, $F(2,96)=63.63$, $p<.001$, $\eta_p^2=.57$, with self-referential encoding enhancing recollection over semantic processing, $F(1,48)=6.52$, $p=.01$, $\eta_p^2=.12$ and semantic processing improving recollection over structural encoding, $F(1,48)=59.86$, $p<.001$, $\eta_p^2=.56$. There was a marginally significant main effect of participant group, $F(1,48)=3.34$, $p=.07$, $\eta_p^2=.07$, with the healthy control group showing higher recollection scores than the aMCI group. Though the interaction between encoding condition and participant group was non-significant, $F(2,96)=.32$, $p=.73$, $\eta_p^2=.01$, a closer look at the data indicated that the significant difference between recollection in the self-reference and semantic conditions was largely driven by the healthy control group ($p=.03$) and that those with aMCI showed more similar levels of recollection between the two encoding conditions ($p=.16$). There was no effect of valence $F(1,48)=.06$, $p=.81$, $\eta_p^2=.001$ nor a significant valence by participant group interaction,

$F(1,48)=1.5$, $p=.23$, $\eta_p^2=.03$. Recollection “remember” scores, calculated according to corrected recognition, are presented in Figure 3.6.

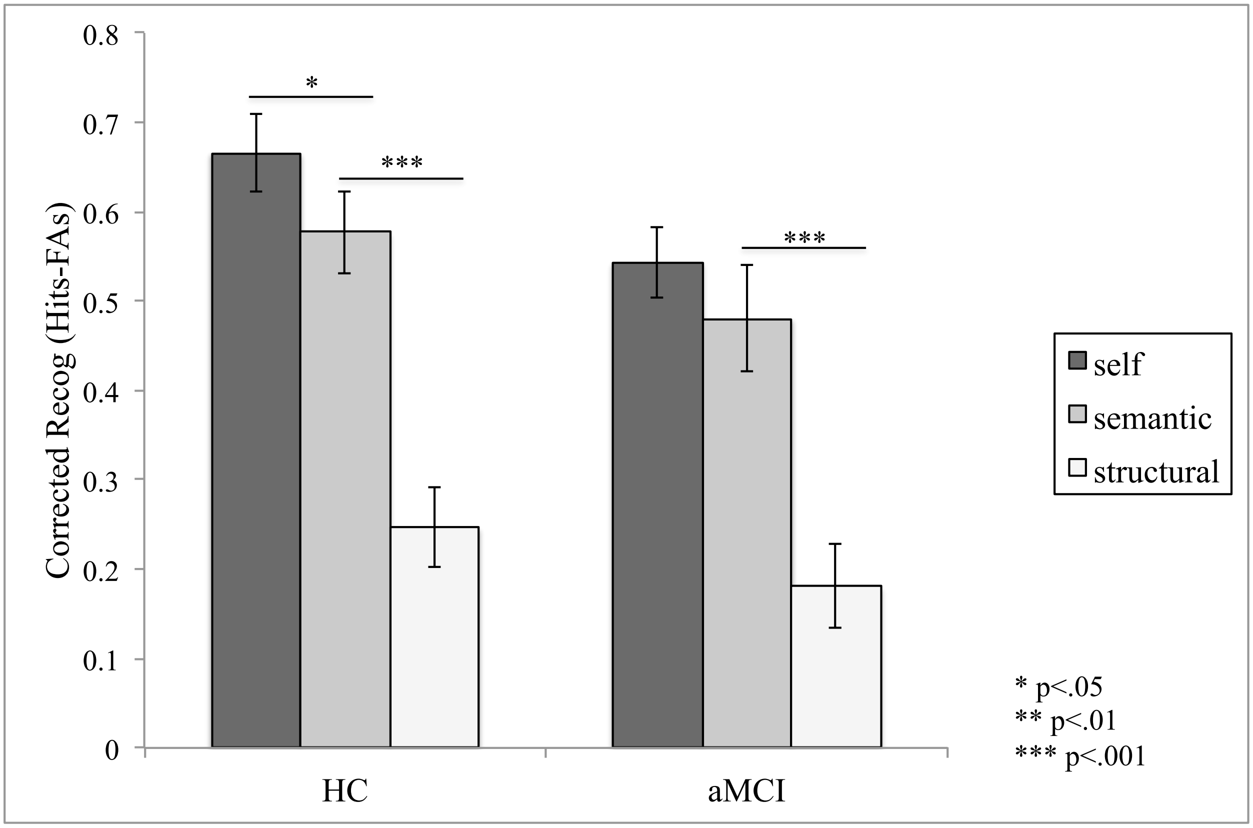

Figure 3.6. Narrative corrected recognition, indicating recollection “remember” scores, as a function of participant group and encoding condition. Error bars represent standard error.

Discussion

Experiment 2 investigated whether the SRE improves memory for narrative information in aMCI and whether recollection for this type of information is also enhanced with use of the strategy. The influence of valence on memory for narrative information in aMCI was further explored. Results indicated that both healthy controls and individuals with aMCI showed the SRE on a test of narrative recognition, however when tested with a cued recall test, the aMCI group did not show a benefit from self-referential encoding above and beyond that of semantic encoding. Similarly, recollection for narrative details was enhanced by "deep encoding" processes in general in aMCI, regardless of whether details were encoded through self-referential or semantic processing. While memory for negatively valenced narrative details was higher in healthy aging and aMCI on the cued recall test, no other effects of valence were apparent. The following is an in-depth discussion of these findings.

SRE for Narrative Information

The current study is the first to show that the SRE effectively improves narrative memory in aMCI. This is significant given that memory for narrative information notably declines in aMCI, a deficit that potentially impacts autobiographical episodic memory in this population. The SRE may therefore provide a useful intervention strategy for enhancing narrative memory in aMCI. It is encouraging that the SRE benefits memory in aMCI for narrative information, which is more ecologically valid than the trait adjective words that are typically tested in SRE paradigms.

Two published studies and Experiment 1 of the current dissertation have investigated the SRE in aMCI for trait adjectives, one of which found an SRE specifically for positive trait adjectives (Leblond et al., 2016) and the other two of which found no difference between self-referential and semantic encoding (Rosa et al., 2015; Experiment 1 of the current dissertation). The fact that an SRE was found in aMCI for narrative information in the present study is inconsistent with prior studies that have been conducted exploring the SRE in aMCI (with the exception of Leblond et al.'s SRE finding specific to positive trait adjectives). Likely, these inconsistencies are due to the stimuli used in the experiments, with Experiment 1 and previous studies using single trait adjective words and the present study (Experiment 2) using narrative information. Narrative material engages different and richer processes than single words (Xu et al., 2005), and older adults have been shown to benefit from the added context available in narratives (Burke & Light, 1981; Johnson, 2003; Stine, Wingfield, & Poon, 1989; Tun & Wingfield, 1993; Wingfield & Stine, 1991). Indeed, a meta-analysis by Johnson (2003) in fact indicated that older adults remember longer narrative passages better than shorter passages, and this was thought to be due to the availability of additional contextual information in the longer passages. It is likely that the rich context of narratives versus single words was associated with the high recognition accuracy exhibited across groups. In order to comprehend narratives, it has been shown that we integrate story information, such as characters and their goals, with our own semantic knowledge, creating a mental representation of the overall event (Zwaan & Radvansky, 1998). Access to this constructed mental representation allows for enhanced recognition accuracy of coherent narrative material (Yarkoni, Speer, & Zacks, 2008). This is further supported by neuroimaging research demonstrating distinct neural patterns associated with learning as context and complexity increases from single words to single sentences to coherent narratives (Xu et al., 2005).

It should be noted, however, that while individuals with aMCI showed the SRE on a test of narrative recognition, they did not show the advantage for self-related processing on a test of narrative cued recall. Instead, "deep encoding" processes, regardless of whether self-referential or semantic, seemed to equally benefit narrative recall in this population. This indicates that while individuals with aMCI benefit from the SRE for narrative information, this is only under circumstances of enhanced external support, inherent in tests of recognition versus recall (Craik & McDowd, 1987). The discrepancy between recognition and recall performance may be further explained by the increased difficulty of using self-initiated retrieval processes evident in aMCI

(Troyer & Murphy, 2007), given that recall performance, with little external support, relies on self-initiated processing (Craik & McDowd, 1987). Overall, the discrepancy between the narrative cued recall and recognition results indicates that individuals with aMCI benefit from the SRE for narrative information, but may require external support to show improved memory with the strategy.

Individuals with aMCI showed better overall recognition memory accuracy for narrative information in the present study when compared to overall memory accuracy for trait adjectives in the Leblond et al. study and in Experiment 1 of the current dissertation. One possibility is that individuals with aMCI were better able to capitalize on the SRE strategy for narrative information than for trait adjective words because of the structure and context inherent in narratives that makes them easier than single words to process and retrieve. Further, the present study explicitly instructed participants to imagine themselves as the protagonist of the narratives, along with any associated thoughts or feelings in the self-reference condition. These explicit instructions may have promoted strategic encoding of the material in aMCI, a population who generally has difficulty with self-initiated encoding strategies but can show improvement with specific encoding instructions (Acevedo & Lowenstein, 2007; Belleville et al., 2006; Hampstead et al., 2008). Though the SRE did not improve narrative memory in aMCI to the extent of their healthy counterparts, it is indeed encouraging that similar to other memory-impaired populations (Grilli & Glisky, 2010, 2011, 2013; Grilli & McFarland, 2011), the SRE effectively enhanced memory for narrative information in aMCI.

Influence of Valence

The cued recall test of narrative details indicated a main effect of valence across participant groups, with negative details better recalled than positive details. Further, an encoding condition by valence interaction revealed that self-referenced details showed higher recall than semantic details only for negatively valenced narratives. For positive narratives, there was no significant difference in recall for those encoded in the self-reference or semantic conditions. The finding of enhanced recall for negative narrative details is consistent with previous work showing more accurate memory for negative versus positive events in younger and older adults (Bohn & Berntsen, 2007; Levine & Bluck, 2004; Kensinger & Schacter, 2006), higher accuracy for negative details of events (Kensinger, 2009; Kensinger, Garoff-Eaton, & Schacter, 2007), and detailed flashbulb memories for negative events, such as 9/11, across the lifespan (Davidson, Cook, & Glisky, 2006; Kensinger, Krendl, & Corkin, 2006; Wolters & Goudsmit, 2005). It is also consistent with Carson et al. (2016), who found negative valence preferences across the lifespan for narrative recall. Last, these findings are consistent with a study by Mah et al. (2017), who found enhanced memory for negative verbal information in aMCI, but inconsistent with the positivity bias they found in healthy older adults.

Findings of enhanced recall for narratives in the present study are contradictory to predictions made by socioemotional selectivity theory (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005), which posits that older adults should show enhanced memory for positive information. They are also inconsistent with one of the only studies on the SRE in aMCI conducted by Leblond et al. (2016), which showed that the SRE in this population was only exhibited for positively valenced information.

While effects of valence were found on the test of narrative cued recall, no influence of valence was indicated on the recognition memory test of narrative details. As discussed by Murphy and Issacowitz (2008), it is likely that the type of memory task employed has an influence on the appearance of valence effects, with recognition tests less sensitive to effects of valence than recall tasks. Indeed, a study by D'Argembeau, Comblain, & Van der Linden (2005) found an influence of valence on the SRE for trait adjectives on a test of free recall but not on a test of recognition, though their results differed from the present in that they showed enhanced memory for positive information on recall. This study also differed from the current study in that participants were young adults. Findings of no effect of valence on recognition of narrative information are consistent with previous work on the SRE for narratives in healthy aging (Carson et al., 2016) and in Experiment 1 of the current dissertation. There is very limited research that has been conducted on the influence of valence on the SRE in aMCI, for either trait adjectives or narrative information, and for different types of memory retrieval formats. This is an area that would benefit from further research.

Individuals with aMCI in the current study made more false alarms (endorsement of unstudied items) than their healthy counterparts on the test of narrative recognition. Interestingly, there was an influence of valence on false alarms made across both healthy aging and aMCI groups, with a higher proportion of false alarms made for positively valenced narrative details. This finding is consistent with past studies of the SRE in healthy aging (Gutchess et al., 2007; Glisky & Marquine, 2009) as well as in aMCI (Experiment 1 of the current dissertation; Leblond et al., 2016). Though accurately retrieved narrative details were not influenced by valence, positive valence was a clear influence on false alarms in both aMCI and healthy control groups. Glisky and Marquine (2009) attributed similar findings of increased false alarms for positive material to evidence that positive information is remembered in a more gist-like, general fashion (Kensinger, Garoff-Eaton, & Schacter, 2007), making it more difficult to distinguish between studied and distractor items.

SRRE for Narrative Information

Yet another factor to consider in examining the efficacy of the SRE is the process(es) on which it exerts its effects. The SRRE, enhanced recollection for material encoded through self-referencing, has been studied in young adults (Conway & Dewhurst, 1995; Conway et al., 2001; Leshikar & Duarte, 2012; van den Bos, Cunningham, Conway, & Turk, 2010), healthy aging (Carson et al., 2016; Genon et al., 2014; Leshikar, Dulas, & Duarte, 2015), and AD (Lalanne et al., 2013; Kalenzaga & Clarys, 2013; Kalenzaga et al., 2013), but has had limited investigation in aMCI. Experiment 1 of the current dissertation found that this population did not show enhanced recollection for material encoded self-referentially specifically, but overall enhanced recollection for deep encoding more generally (including both self-referencing and semantic encoding). It was hypothesized that perhaps the structure and context inherent in narrative information would make the stimuli in the current study easier to remember for those with aMCI and allow for this participant group to capitalize on self-referential processing (as seen in the results for overall recognition). There was an effect of encoding condition across both healthy aging and aMCI participant groups, indicating higher recollection for self-referenced narrative details over those encoded through semantic processing (and both superseding that of structural processing), with no significant condition by group interaction. However, closer inspection of the data revealed that this effect was largely driven by the healthy control group; the aMCI group did not show a specific improvement in recollection for self-referenced material over semantic encoding, but rather improved recollection with deep encoding in general. Though an SRRE pattern is apparent in the aMCI group, the variability is larger in the semantic condition than in the self-reference condition. With a larger sample size, the SRRE may have thus become apparent. In any case, it is promising that deep encoding in general improved recollection for narrative details in aMCI, given that recollection is an important aspect of episodic memory that is known to decline in aMCI (Anderson et al., 2008; Hudon et al., 2009; Irish et al., 2010; Serra et al., 2010; Westerberg et al., 2006). Interestingly, the difference between participant groups in the analysis of overall recollection scores only reached marginal significance, indicating that those with aMCI benefitted from deep encoding processes to a similar extent to those without aMCI. There was no influence of valence on recollection in either healthy aging or aMCI groups. Due to the low frequency of "know" responses indicating familiarity, we were unable to analyze the contribution of this memory process to the SRE for narrative information in aMCI. This was unfortunate but did not impede the main goal of studying recollection for narrative information with the SRE in aMCI.

Conclusions

The SRE has been primarily studied using trait adjective words as stimuli, which have little ecological validity and relevance to everyday functioning. Memory for narrative information is compromised in healthy aging and more notably in aMCI. This type of information has real-world importance and provides a valuable target for improvement with the SRE strategy. The current study is the first to show that memory for narrative information is improved with self-referential encoding in aMCI, particularly in circumstances of additional retrieval support. Cued recall of narratives was enhanced for negative details, particularly in the self-reference condition, however the narrative recognition test showed no influence of valence. Recollection was enhanced by deep encoding in general (i.e., similar for self-reference and semantic conditions) in aMCI, thus a specific SRRE was not found in this population. Overall, the SRE provides a valuable intervention tool for improving memory for narrative information in aMCI, and may even be extended to benefit autobiographical episodic memory in this population.

CHAPTER 4

Experiment 3: The Maintenance of the SRE for Trait Adjectives and Narrative Information in Healthy Aging

Experiment 2 indicated that self-referential encoding improved narrative memory in healthy aging and aMCI, when retrieval support was provided in the form of a recognition test. Though healthy controls benefitted from self-referential processing on a test of narrative cued recall, individuals with aMCI showed similar benefit from self-reference and semantic encoding conditions. A similar pattern was apparent for recollection, with self-referential processing improving recollection in healthy aging (i.e., an SRRE) but equivalent benefit to recollection seen for the aMCI group from self-reference and semantic encoding conditions. The SRE has shown to be robust in healthy aging for trait adjectives and narrative material (as further evidenced by Experiments 1 and 2 of the current dissertation). The purpose of Experiment 3 was to investigate the long-term benefits of the SRE in healthy aging, in order to determine whether the strategy may serve as an intervention for episodic memory decline in this population.

The SRE has been shown to improve episodic memory in various populations experiencing memory change, due to healthy cognitive aging (Carson et al., 2016; Dulas, et al., 2011; Genon et al., 2014; Glisky & Marquine, 2009; Gutchess et al., 2007; Hamami et al., 2011; Leblond et al., 2016; Leshikar & Duarte, 2014; Mueller et al., 1986; Rosa et al., 2011; 2015; 2016; Trelle et al., 2015), aMCI (Leblond et al., 2016; Rosa et al., 2015; 2016), AD (Kalenzaga & Clarys, 2013; cf. Genon et al., 2014; Lalanne et al., 2013), and acquired brain injury (Grilli & Glisky, 2010, 2011, 2013; Grilli & McFarland, 2011). Many of these studies explicitly suggest that the SRE could represent a valuable intervention strategy for improving episodic memory in memory-disordered populations, however there has been little research investigating whether the benefits of the SRE are maintained following the single test session during which an individual participates in an SRE experiment. As mentioned above, studies by Conway & Dewhurst (1995) and Conway et al. (2001) investigated whether the SRE and SRRE were apparent following 1-hour and 24-hour delays after study in healthy young adults, but whether the SRE was maintained was not measured in these studies, as there was no initial testing of the SRE before the delay periods. Studies by Conway and colleagues suggested that the SRE and SRRE may be apparent after a prolonged period of time, though they did not directly test the maintenance of the effect.

To date, no study has tested whether the SRE continues to benefit memory after a prolonged period of time in populations experiencing episodic memory decline, such as those undergoing healthy cognitive aging. Additionally, whether the benefit to recollection seen in healthy aging with self-referential processing (i.e., the SRRE) is maintained following a time delay has likewise never been investigated. Findings that the SRE and SRRE continue to benefit memory after a prolonged period of time in healthy aging would be especially significant for designing interventions for populations experiencing episodic memory decline and impairment. The viability of the SRE as an intervention hinges on its ability to continue to improve memory over time.

The nature of the encoded information may influence the extent to which the SRE is maintained over time. For example, Experiment 2 of the current dissertation indicated that the SRE benefitted memory for narrative information in aMCI, while trait adjectives did not receive the same benefit. Carson et al. (2016) found that recognition memory for narrative information was much more accurate in healthy young and older adults than for trait adjectives. Furthermore, Experiments 1 and 2 of the current dissertation indicated that in both healthy aging and aMCI, recognition memory for narrative information was higher than for trait adjectives. The added context and meaningfulness of narratives may not only contribute to more accurate memory for this type of information, but also potentially to the maintenance of the SRE over time.

Last, though theories such as socioemotional selectivity theory (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005) predict that older adults show enhanced memory for positively valenced information, studies of the SRE in healthy aging and aMCI do not consistently find a "positivity bias" in memory (e.g., Carson et al., 2016; Gutchess et al., 2007; Glisky & Marquine, 2009; Leblond et al., 2016). Experiment 1 of the current dissertation found no effect of valence on the recognition of trait adjectives and Experiment 2 found enhanced recall of negatively valenced narratives but no influence of valence on recognition of narrative details. Certain research has indicated that effects of valence may only become apparent in situations of increased retrieval difficulty, for example on recall tests versus recognition tests (Murphy & Isaacowitz, 2008). This theory was evident in the findings of Experiment 2, which showed an influence of valence on a test of narrative recall but none on a test of recognition. In both Experiments 1 and 2, no effects of valence were found on recognition tests of trait adjectives and narrative information. Perhaps this was because the retrieval circumstances were not difficult enough to elicit effects of valence. If this was indeed the case, testing memory for information that was encoded many days prior would increase the difficulty of the recognition task, thereby perhaps showcasing any influence of material valence on memory.

Experiment 3 examined the SRE and SRRE for trait adjectives and narrative information in healthy aging, across two time points, approximately one week apart. Showcased in Experiments 1 and 2, material was encoded and tested during the initial study session, however at the one-week follow-up session (Experiment 3), memory was again tested, without the benefit of study. It was predicted that: (a) healthy older adults would show a maintained SRE for both trait adjective and narrative information across two time points, however overall memory would likely decrease at the second time point; (b) the SRRE would be apparent at both time points, though overall recollection may decline by the second test session; (c) if valence preferences became apparent in the follow-up testing session on the recognition tests, they would be in the direction of a positivity bias. Valence preferences on the narrative cued recall test may show enhanced memory for negatively valenced details, consistent with results of Experiment 2.

Methods

Participants

Participants included the healthy older adults considered as control participants in Experiments 1 and 2. Thirty healthy older adults (age: *M*=70.1, *SD*=5.5) participated in the study. See Experiment 1, pg. 26 for further detail regarding the healthy older adult sample.

Procedure

During the initial study and test session, participants were administered both the trait adjective and narrative paradigms described in Experiments 1 and 2. Order of paradigm administration was counterbalanced across participants. The follow-up test session (Experiment 3), which occurred approximately one week following the initial study session, involved the re-testing of memory for trait adjective and narrative material using the same tests employed in Experiments 1 and 2.

Study and Test Session #1 (Initial Session)

Trait adjective paradigm. The trait adjective paradigm administered was identical to the paradigm described in Experiment 1. The paradigm is reviewed here; however, please see Experiment 1, p. 27 for a more detailed description.

Procedure. Participants made yes / no judgments about 90 trait adjective words under three blocked study conditions: self-reference ("Does this word describe me?"), semantic ("Does this word describe a desirable personality trait?"), and structural ("Does this word contain the letter 'e'?"). Trait adjectives were presented on a computer screen using E-Prime software (Psychology Tools). Presentation of each block commenced with an instruction screen indicating which of the three decisions (self-reference, semantic, structural) was to be made for the subsequent presentation of 10 trait adjective words. Each individual trial consisted of a fixation cross presented for 500 ms followed by a trait adjective word presented for 4500 ms, during which time the participant was prompted to make his/her yes/no judgment. This was followed by a 5000 ms fixation cross. Presentation order of words within blocks was randomized across participants. Practice trials preceded the test trials, and response type (yes or no) was recorded for each judgment. A 10-minute retention interval followed the study phase, during which WAIS-III Digit Span, Digit Symbol Coding, Digit Symbol Incidental Learning, and Digit Symbol Free Recall were administered. Following the retention interval, participants were given a recognition test in which they were asked to distinguish previously studied trait adjectives from distractors (old/new button press).

For the recognition test, all 90 studied trait adjectives and 90 distractors were presented in random order, with the same list of distractor items presented to all participants. When a participant indicated that a word had been previously studied ("old"), he or she was then asked to make an additional remember/know decision with a button press. The recognition test was self-paced and responses were recorded by E-Prime software.

Narrative paradigm. The narrative paradigm administered was identical to the one described in Experiment 2. The paradigm is briefly reviewed here; however please see Experiment 2, p. 49 for a more detailed description

Procedure. Participants made yes / no judgments about 36 narratives under three blocked study conditions, self-reference, semantic, and structural. Each block of self-reference condition trials began with an instruction screen stating, "As you read the following stories, imagine that you are the person who actually experienced the event and is telling the story. Ask yourself, 'Can I easily imagine myself experiencing this event?' Press the yellow button for 'yes' and the blue button for 'no'." Subsequently, during each self-reference condition trial, participants were presented with a narrative and the prompt, "Easy to imagine myself?" for which they were asked to make a yes/no button press. Each block of semantic condition trials began with an instruction screen stating, "As you read the following stories, think about the event being described. Ask yourself, 'Does this story describe a positive event?' Press the yellow button for 'yes' or the blue button for 'no'." Subsequently, during each semantic condition trial, participants were presented with a narrative and the prompt, "Positive event?" for which they were asked to make a yes/no button press. Each block of structural condition trials began with an instruction screen stating, "As you read the following stories, count the number of times the word 'the' appears. Ask yourself, 'Does the word 'the' appear more than 3 times?' Press the yellow button for 'yes' and the blue button for 'no'." Subsequently, during each structural condition trial, participants were presented with a narrative and the prompt, "'The' more than 3 times?" for which they were asked to make a yes/no button press. Narratives were presented on a computer screen with E-Prime software (Psychology Tools). Each individual trial began with a fixation cross presented for 500 ms followed by a narrative presented for 20 sec[5], during which time the participant was prompted to make the yes/no judgment. Each trial ended with the presentation of a fixation cross for 5 sec. Reaction time and response type (yes/no) was recorded for each judgment. During a 10-minute retention interval, participants were administered the National Adult Reading Test-Revised (NART-R) and a subtraction task devised by the investigators.

Following the retention interval, a cued recall test was administered, during which participants were asked to recall as many details as possible aloud from each narrative, with the narrative's title serving as a cue. A recognition test was subsequently administered and asked participants to distinguish previously studied narrative details from distractor details (old/new button press). For the recognition test, 36 studied narratives details and 36 distractor details were presented in random order. Half of the distractor details had a similar theme to studied narrative details and half had novel themes. See Experiment 2, Figure 3.2 (p. 52) for examples. When a participant indicated that a narrative detail had been previously studied ("old"), they were asked to make an additional remember/know decision with a button press. The recognition test was self-paced, and responses were recorded.

Test Session #2 (Follow-up Session)

The second session of the experiment occurred approximately one-week following the initial study and test session. During the follow-up test session, memory for trait adjectives and narratives studied during the initial study session were once again tested, however participants did not have the opportunity to study the material again at this point. Recognition tests were employed to test memory and the order of administration of the trait adjective and narrative

[5] The duration for which narratives were presented was determined by pilot testing for Carson et al. (2016).

recognition tests was consistent with the initial study session for each participant (as the order of the paradigms was counterbalanced across participants).

Trait adjective recognition test. Participants completed the same recognition test that they were administered in the first study session, including the remember/know distinction. The same 90 words originally studied were again presented, in random order, along with 90 distractors that were different than the distractors presented during the recognition test of the first study session. Word lists included half positively valenced and half negatively valenced trait adjectives. Participants were again asked to make a remember/know distinction for words indicated as “old” (studied). The recognition test was self-paced, and responses were recorded.

Narrative cued recall test. Participants completed the same narrative recall test that they were administered during the initial study session (approximately one week prior; Experiment 2). Titles of studied narratives appeared on a computer screen and participants were asked to state aloud any details he/she could recall from that story. Titles appeared in random order, thus they did not appear in the same order as in the initial study session (Experiment 2).

Scoring of narrative cued recall test. As described in Experiment 2, narrative cued recall was scored according to a scoring key created for each narrative in order to standardize scoring between raters. An example of the narrative cued recall scoring procedure is presented in Figure 3.3 (p.53). Details were accepted if they had the same or equivalent meaning to narrative components (as in Fotopoulou et al., 2008). Details were then tallied according to the condition and valence in which they were initially presented. This allowed comparison of overall recall for narrative information between the three encoding conditions and two valence conditions. Scoring was performed by two independent raters, blind to the allocation of narratives to the study conditions. Inter-rater reliability will be calculated using Pearson’s correlation coefficient.

Narrative recognition test. Similar to the recognition test administered during the initial study session, the narrative recognition test of the follow-up session included details from all 36 narratives originally studied. However, the 36 distractor narrative details presented during the recognition test were different than the distractors presented during the first session. Distractor details once again included 18 details with the same theme as the studied narratives details and 18 with themes unrelated to the studied narratives. There were an equal number of positive and negative distractor details presented. When a participant indicated that a narrative detail had been previously studied ("old"), he or she was asked to make an additional remember/know decision with a button press. The recognition test was self-paced, and responses were recorded.

Results

Neuropsychological Testing

Participant performance on neuropsychological measures is presented in Experiment 1 Table 2.1. All participants performed in the average range or higher, compared to age and education-matched norms, on tests of episodic memory, processing speed, language, working memory, and executive function. Symptoms of anxiety and depression were found to be within normal limits on a self-report measure (HADS).

Trait Adjective Recognition (SRE)

Trait adjective recognition memory scores were calculated by subtracting the proportion of false alarms (distractor items identified as "old") from the proportion of hits (items identified as "old" that had in fact been studied), creating an overall "corrected recognition" score (uncorrected scores presented in Table 4.1). Each participant had a single false alarm rate across study conditions, as all trait adjectives were tested in the same recognition task. The scores of one participant could not be analyzed due to technical issues during testing.

Corrected recognition results are presented in Figure 4.1. A 2×3×2 (encoding condition × valence × time) repeated-measures ANOVA revealed a main effect of condition, $F(2,56)=57.22$, $p<.001$, $\eta_p^2=.67$, with planned contrasts indicating enhanced memory for trait adjectives encoded in the self-reference condition over the semantic condition, $F(1,28)=22.93$, $p<.001$, $\eta_p^2=.45$, and enhanced memory for trait adjectives encoded in the semantic condition over the structural condition, $F(1,28)=40.07$, $p<.001$, $\eta_p^2=.59$. There was no main effect of valence, $F(1,28)=1.72$, p=.20, $\eta_p^2=.06$. A significant effect of time, $F(1,28)=54.71$, p<.001, $\eta_p^2=.66$, indicated an overall decrease in memory at follow-up testing. There was no condition × valence interaction, $F(2,56)=.86$, $p=.43$, $\eta_p^2=.03$, nor was the valence × time interaction significant, $F(1,28)=1.53$, p=.23, $\eta_p^2=.05$. A significant interaction between encoding condition × time revealed that the decrease in corrected recognition scores between the two time points for trait adjectives encoded in the self-reference and semantic conditions was significant (*p*s<.001), however the structural condition remained relatively consistent (and low) between the two time points ($p=.06$).

False alarms. Proportion of false alarms (distractor trait adjectives indicated as "old"), presented in Table 4.1, was analyzed in a 2×2 repeated measures ANOVA (valence × time). A main effect of valence, $F(1,28)=71.39$, p<.001, $\eta_p^2=.72$, indicated a greater proportion of false alarms for positive versus negative words. A main effect of time, indicated that more false alarms were made during the recognition test of the follow-up session than the initial session, $F(1,28)=14.04$, $p=.001$, $\eta_p^2=.33$. There was no significant valence × time interaction revealed, $F(1,28)=.24$, $p=.14$, $\eta_p^2=.08$.

Table 4.1

Trait Adjective Recognition and Recollection "Remember" Scores Over One-Week in Healthy Aging

			Overall Recognition		Recollection "Remember" Scores	
	Condition	Valence	T1	T2	T1	T2
Hits	Self-Reference	Pos	.85 (.13)	.70 (.20)	.60 (.31)	.33 (.24)
		Neg	.73 (.19)	.49 (.21)	.45 (.27)	.19 (.15)
	Semantic	Pos	.74 (.18)	.59 (.19)	.47 (.27)	.26 (.22)
		Neg	.62 (.17)	.44 (.20)	.33 (.23)	.15 (.13)
	Structural	Pos	.48 (.22)	.57 (.22)	.26 (.18)	.23 (.18)
		Neg	.36 (.20)	.32 (.22)	.20 (.16)	.12 (.14)
False Alarms		Pos	.35 (.17)	.48 (.25)	.19 (.17)	.20 (.22)
		Neg	.19 (.10)	.27 (.18)	.09 (.09)	.10 (.13)

Note. Values represent means (standard deviations). T1=time 1 (initial session); T2=time 2 (follow-up session); Pos=positive; Neg=negative.

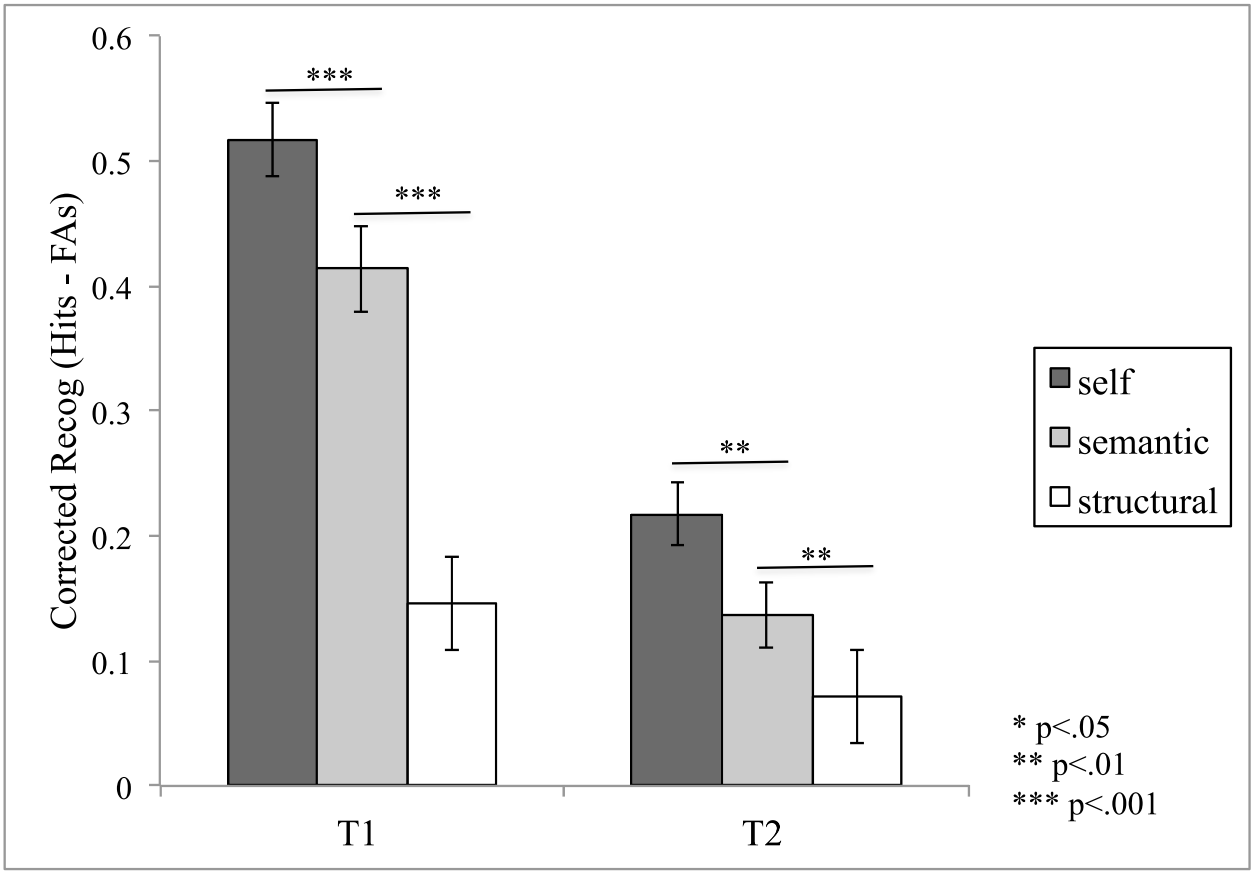

Figure 4.1. Trait adjective corrected recognition scores indicating recognition memory accuracy, as a function of time and encoding condition. T1=time 1 (initial session); T2=time 2 (follow-up session). Error bars represent standard error.

Trait Adjective Recollection and Familiarity (SRRE)

Experiences of recollection and familiarity during the recognition test were measured using a remember (recollection)/ know (familiarity) button press. Scores were then calculated with the Independence Remember Know (IRK) method, which holds that recollection and familiarity are independent processes and therefore familiarity should not simply reflect an absence of recollection (Jacoby, Yonelinas, & Jennings, 1997; Yonelinas & Jacoby, 1995). Recollection scores were calculated for each study condition according to corrected recognition [proportion remember hits – proportion remember false alarms]. Familiarity was calculated for each study condition as [proportion of know hits/1-proportion of remember hits] – [proportion know false alarms/1-proportion remember false alarms]. See Table 4.1 for uncorrected scores.

A 3×2×2 repeated measures ANOVA (encoding condition × valence × time) of "remember" scores revealed a main effect of condition, $F(2,56)=45.96$, $p<.001$, $\eta_p^2=.62$, with self-referential encoding enhancing recollection over semantic processing, $F(1,28)=25.83$, $p<.001$, $\eta_p^2=.48$ and semantic processing improving recollection over structural encoding, $F(1,28)=27.77$, $p<.001$, $\eta_p^2=.50$. There was no significant main effect of valence, $F(1,28)=2.38$, $p=.13$, $\eta_p^2=.08$, however the encoding condition × valence interaction was significant, with positive words showing higher "remember" scores than negative words in the self-reference condition ($p=.04$), but no differences in valence in the semantic or structural conditions (ps>.05). A main effect of time, $F(1,28)=42.14$, $p<.001$, $\eta_p^2=.60$, indicated that "remember" scores were significantly higher at the first test session than the follow-up session. Last, a significant encoding condition × time interaction was found, $F(2,56)=19.99$, $p<.001$, $\eta_p^2=.42$. While self-referential encoding enhanced recollection over semantic encoding at both the initial test session ($p<.001$) and the follow-up session ($p=.02$), the difference between semantic and structural encoding was significant at the initial testing ($p<.001$) but non-significant at follow-up ($p=.11$). Refer to Figure 4.2 for corrected recognition "remember" scores.

Eight participants could not be included in the analysis of familiarity "know" scores, as they provided too few responses across the two time points. Mean scores from the remaining 22 participants are shown in Figure 4.3. A 3×2×2 (encoding condition × valence × time) of familiarity scores revealed a main effect of encoding condition, $F(2,42)=19.33$, $p<.001$, $\eta_p^2=.48$;

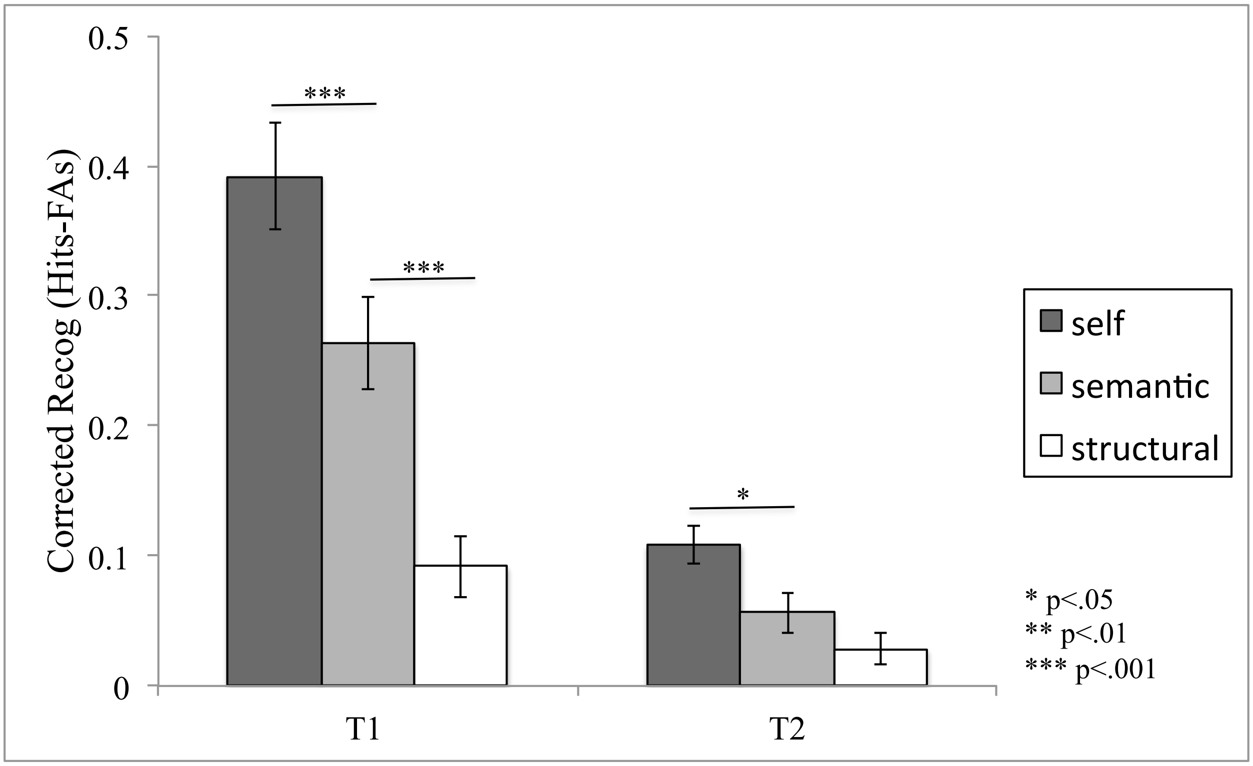

Figure 4.2. Trait adjective corrected recognition, indicating recollection "remember" scores, as a function of encoding condition and time. T1=Time 1 (initial session); T2=Time 2 (follow-up session). Error bars represent standard error.

planned contrasts indicated significantly higher familiarity scores in the self-reference condition over the semantic condition, $F(1,21)=8.83$, $p=.007$, $\eta_p^2=.30$, and significantly higher familiarity scores in the semantic condition than the structural condition, $F(1,21)=13.63$, $p<.001$, $\eta_p^2=.39$. There was no significant effect of valence, $F(1,21)=.02$, $p=.90$, $\eta_p^2=.001$. A main effect of time, $F(1,21)=52.40$, $p<.001$, $\eta_p^2=.71$, revealed significantly higher familiarity scores at the initial study session than the follow-up session. A significant encoding condition × time interaction was found, $F(2,42)=11.59$, $p<.001$, $\eta_p^2=.36$, with further analyses indicating that while familiarity scores in the self-reference and semantic encoding condition dropped significantly at the follow-up session (ps<.001), there was no significant difference between the two time points for familiarity scores in the structural condition, *p*=.70 (as scores were low at both time points). The valence × time interaction was not found to be significant, $F(1,21)=.94$, $p=.34$, $\eta_p^2=.04$.

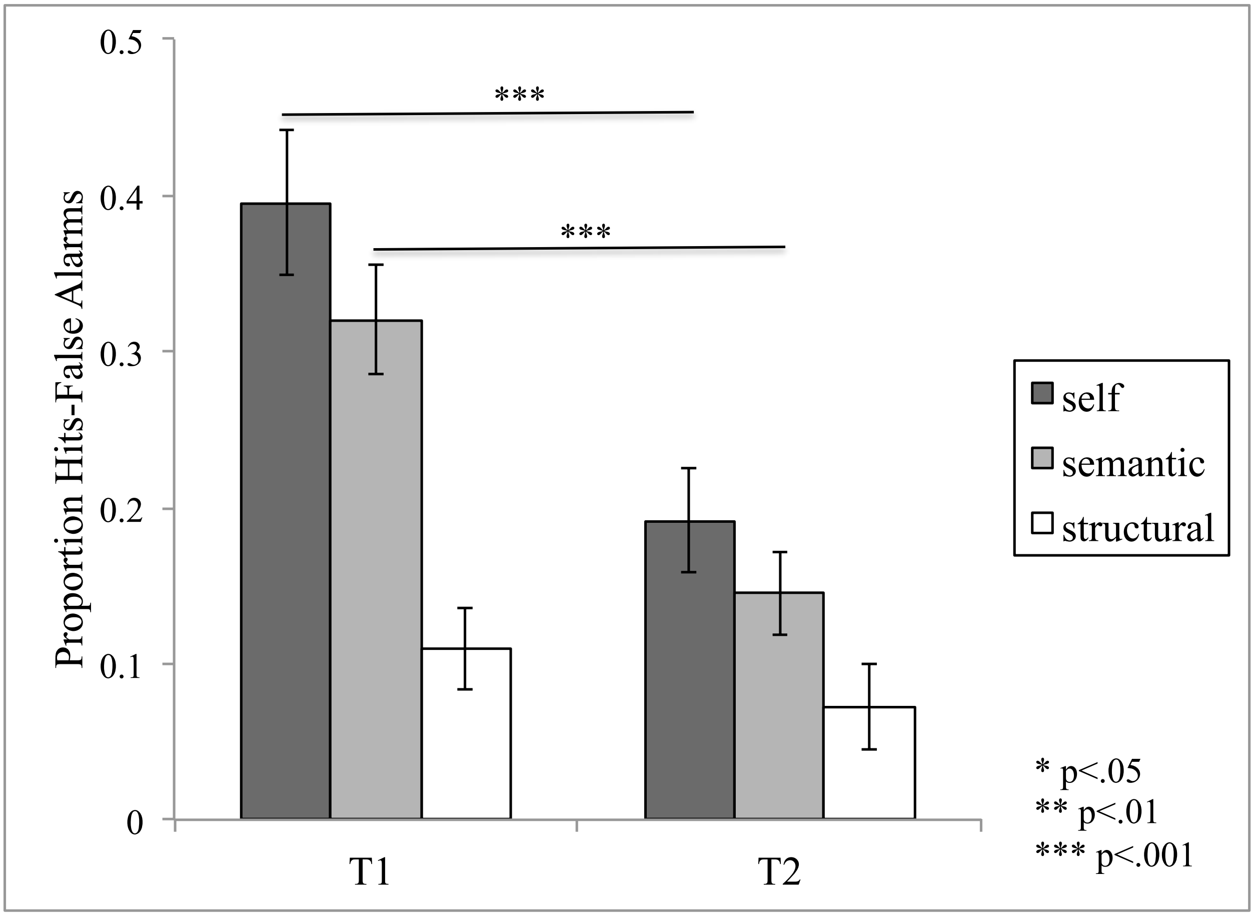

Figure 4.3. Trait adjective familiarity "know" scores, as a function of encoding condition and time. Error bars represent standard error.

Narrative Cued Recall (SRE)

Inter-rater reliability was calculated using Pearson's correlation coefficient and reliability between raters was high with a coefficient of 0.99. A 3×2×2 (encoding condition × valence × time) repeated-measures ANOVA revealed a main effect of condition, $F(2,58)=29.74$, $p<.001$, $\eta_p^2=.51$, with planned contrasts indicating no significant different between narratives encoded in self-reference or semantic conditions, $F(1,29)=1.96$, $p=.17$, $\eta_p^2=.06$, but significantly higher recall in the semantic condition than in the structural condition, $F(1,29)=23.66$, $p<.001$, $\eta_p^2=.45$. A main effect of valence, $F(1,29)=42.47$, $p<.001$, $\eta_p^2=.59$, revealed higher recall for negative than positive details. A main effect of time was found, $F(1,29)= 139.77$, $p<.001$, $\eta_p^2=.83$, indicating significantly higher recall scores at the initial test session than the follow-up session. A significant interaction between encoding condition and time was found, $F(2,58)=10.71$, $p<.001$, $\eta_p^2=.27$, and pairwise comparisons, indicated that while higher recall scores were found for the self-reference over semantic condition in the initial test session ($p<.05$), recall was not significantly different between these conditions at follow-up ($p=.99$). The recall advantage for semantic encoding over structural encoding was evident at both time points (ps<.001). Neither interactions between encoding condition and valence, $F(2,58)=2.19$, $p=.12$, $\eta_p^2=.07$, nor valence and time, $F(1,29)=1.38$, $p=.25$, $\eta_p^2=.05$, were found to be significant. See Figure 4.4 for narrative cued recall scores.

Narrative Recognition (SRE)

Narrative recognition scores were calculated by subtracting the proportion of false alarms from the proportion of hits, resulting in a “corrected recognition” score. Each participant had a single false alarm rate across study conditions. See Table 4.2 for uncorrected scores. A 3×2×2 (encoding condition × valence × time) repeated-measures ANOVA revealed a main effect of condition, $F(2,58)=57.80$, $p<.001$, $\eta_p^2=.67$, with planned contrasts indicating enhanced memory for narrative details encoded in the self-reference condition over the semantic condition, $F(1,29)=7.38$, $p=.01$, $\eta_p^2=.20$, and enhanced memory for narrative details encoded in the semantic condition over the structural condition, $F(1,29)=58.63$, $p<.001$, $\eta_p^2=.67$. No main effect of valence was revealed, $F(1,29)=.82$, $p=.37$, $\eta_p^2=.03$. A main effect of time was revealed, $F(1,29)= 45.0$, $p<.001$, $\eta_p^2=.61$, indicating that corrected recognition scores were significantly lower at the follow-up test session than at the initial session. A significant interaction between encoding condition × time was found, $F(2,58)=9.2$, $p<.001$, $\eta_p^2=.24$, and subsequent pairwise comparisons, indicated that while performance dropped significantly in the self-reference and semantic conditions between the initial test session and follow-up (*p*s<.001), the difference between the timepoints for the structural condition was not significant ($p=.45$). Neither

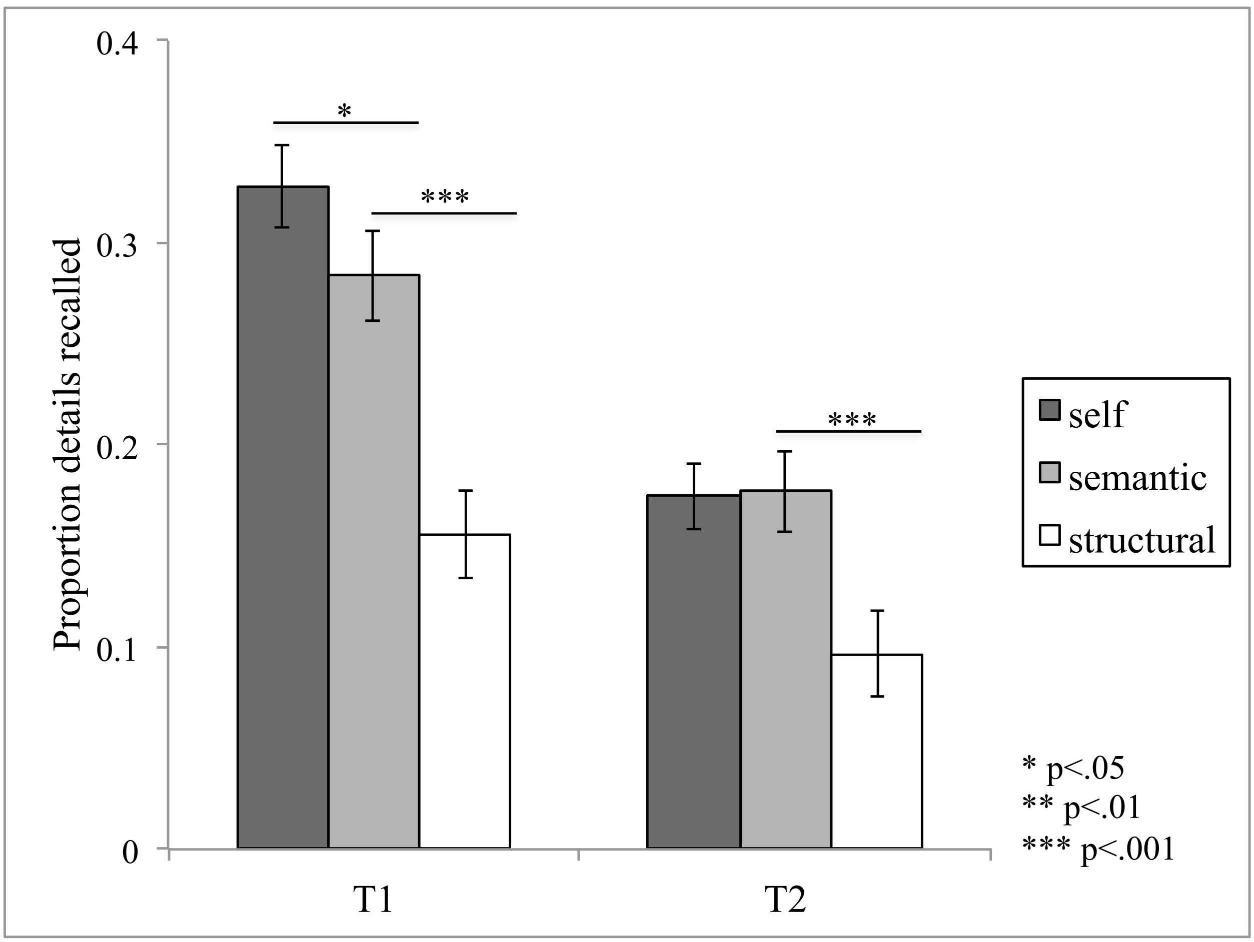

Figure 4.4. Narrative cued recall scores, as a function of encoding condition and time. T1=time 1 (initial session); T2= time 2 (follow-up session). Error bars represent standard error.

Table 4.2

Narrative Recognition and Recollection "Remember" Scores Over One-Week in Healthy Aging

			Overall Recognition		Recollection "Remember" Scores	
	Condition	**Valence**	**T1**	**T2**	**T1**	**T2**
Hits	Self-Reference	Pos	.87 (.13)	.75 (.23)	.68 (.27)	.48 (.31)
		Neg	.88 (.14)	.80 (.12)	.72 (.27)	.54 (.29)
	Semantic	Pos	.82 (.16)	.74 (.19)	.63 (.31)	.43 (.26)
		Neg	.83 (.14)	.67 (.20)	.59 (.29)	.43 (.27)
	Structural	Pos	.44 (.27)	.53 (.29)	.24 (.27)	.23 (.22)
		Neg	.49 (.27)	.49 (.25)	.32 (.28)	.28 (.24)
False Alarms		Pos	.10 (.08)	.17 (.10)	.04 (.05)	.08 (.09)
		Neg	.08 (.07)	.14 (.15)	.03 (.04)	.05 (.09)

Note. Values represent means (standard deviations). T1=time 1 (initial session); T2=time 2 (follow-up session); Pos=positive; Neg=negative.

interactions between encoding condition and valence, $F(2,58)=.86$, $p=.43$, $\eta_p^2=.03$, nor valence and time, $F(1,29)=.92$, $p=.35$, $\eta_p^2=.03$, were found to be significant. See Figure 4.5 for corrected recognition performance across the two time points.

False alarms. Scores are presented in Table 4.2. Proportion of false alarms (distractor narrative details endorsed as "old") was analyzed in a 2×2 repeated measures ANOVA (valence × time). A main effect of valence, $F(1,29)=4.26$, $p=.048$, $\eta_p^2=.13$ indicated that more false alarms were made for positive narrative details than for negative details across the two time points. A main effect of time, $F(1,29)=14.51$, $p=.001$, $\eta_p^2=.33$ revealed significantly more false alarms made during the follow-up test session than the initial session. No significant valence × time interaction was found, $F(1,29)=.23$, $p=.64$, $\eta_p^2=.008$.

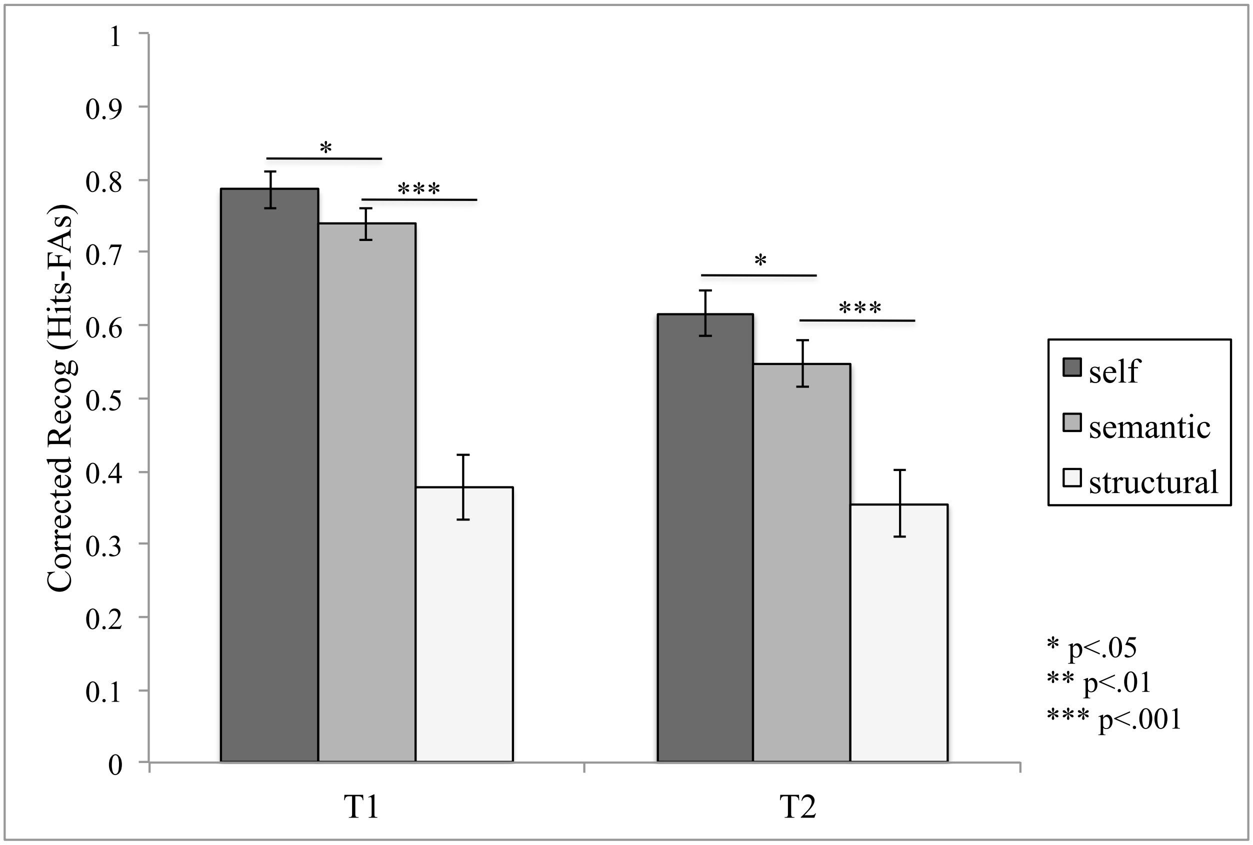

Figure 4.5. Narrative corrected recognition scores indicating recognition memory accuracy, as a function of time and encoding condition. T1=time 1 (initial session); T2=time 2 (follow-up session). Error bars represent standard error.

Narrative Recollection (SRRE)

Experiences of recollection and familiarity during the recognition test was measured using a remember (recollection)/ know (familiarity) button press. Scores were then calculated with the Independence Remember Know (IRK) method (Jacoby, Yonelinas, & Jennings, 1997; Yonelinas & Jacoby, 1995). Recollection scores were calculated for each study condition according to corrected recognition [proportion remember hits – proportion remember false alarms]. See 4.2 for uncorrected scores. As in Experiment 2, there were few “know” button presses made indicating Familiarity and this prevented further analysis of familiarity scores. Though unfortunate, this did not impede the main goal of studying recollection across time points.

A 3×2×2 (encoding condition × valence × time) repeated measures ANOVA of recollection scores revealed a main effect of condition, $F(2,58)=48.13$, $p<.001$, $\eta_p^2=.62$, with self-referential encoding enhancing recollection over semantic processing, $F(1,29)=6.96$, $p=.01$, $\eta_p^2=.19$ and semantic processing improving recollection over structural encoding, $F(1,29)=53.74$, $p<.001$, $\eta_p^2=.65$. There was a main effect of valence $F(1,29)=4.59$, $p=.04$, $\eta_p^2=.14$, which indicated that negative narrative details promoted recollection better than positive narrative details across time points. Additionally, a main effect of time, $F(1,29)=36.58$, $p<.001$, $\eta_p^2=.56$, indicated that recollection scores were significantly higher at the initial test session than the follow-up session. A significant encoding condition × time interaction was found, $F(2,58)=10.31$, $p<.001$, $\eta_p^2=.26$, indicating that while there was a significant decrease in recollection between time points in the self-reference and semantic conditions (ps<.03), there was no significant difference in recollection in the structural condition between time points ($p=.10$). Neither an interaction between encoding condition × valence, $F(2,58)=1.2$, $p=.31$, $\eta_p^2=.04$, nor between valence × time, $F(1,29)=.54$, $p=.47$, $\eta_p^2=.02$ was revealed. Recollection “remember” scores, calculated according to corrected recognition, are presented in Figure 4.6.

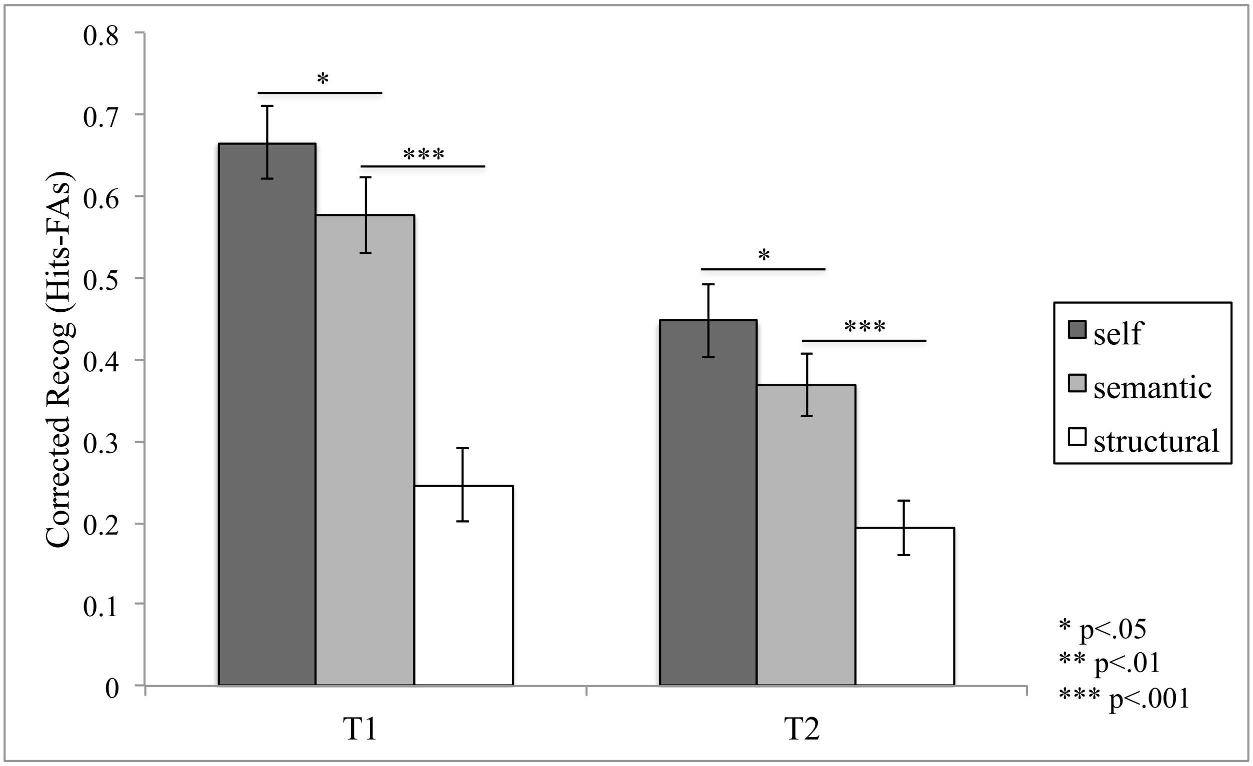

Figure 4.6. Narrative corrected recognition, indicating recollection "remember" scores, as a function of encoding condition and time. T1=Time 1 (initial session); T2=Time 2 (follow-up session). Error bars represent standard error.

Discussion

Experiment 3 investigated whether the SRE and SRRE that are apparent in various populations, including those with memory disorders, continue to benefit memory following a one-week delay. Participants were healthy older adults, a population who commonly experiences episodic memory decline (e.g., Allen et al., 2002; Levine et al., 2002; Nyberg et al., 1996; Piolino et al., 2006; 2009). This investigation is the first of its kind, and crucial for determining whether the SRE constitutes a viable memory intervention strategy that benefits memory over a prolonged period of time, a suggestion that has been made by many authors, but never specifically examined. The current experiment examined whether the SRE and SRRE are maintained over time for two types of encoded stimuli- trait adjectives, which are the most common type of stimuli used in studies of the SRE and narrative information, which is more meaningful and ecologically valid than single trait adjective words. Furthermore, potential effects of valence on the SRE and SRRE were examined across the two time points.

Results indicated that the SRE remained present following the delay for both trait adjectives and narrative information when tested using a recognition task, though memory for trait adjectives dropped significantly by follow-up testing. While cued recall of narrative information showed an SRE at initial testing, self-referential encoding did not benefit recall over and above that of semantic processing at follow-up. Interestingly, the SRRE found for trait adjectives and narrative information at initial testing remained at follow-up, indicating that recollection continued to be enhanced by self-referential processing following a delay. Enhanced memory was found for negatively valenced details in the cued recall test and also for recollection of narrative information. The following is a discussion of the major findings of Experiment 3.

The SRE for Trait Adjectives Following a One-Week Delay

The SRE was established as a robust phenomenon largely based on studies that administered trait adjective paradigms (see Symons & Johnson, 1997). This type of paradigm continues to be the most popular method of SRE investigation. For this reason, a trait adjective paradigm was administered for the first examination of whether the SRE persists following a one-week delay. Results indicated that the SRE for trait adjectives was still apparent in healthy aging following the delay, though overall recognition memory for this type of material significantly decreased. The appearance of the SRE for trait adjectives following a delay provides evidence that the SRE continues to benefit memory in healthy aging over time. As mentioned previously, the SRE has been found in multiple studies for trait adjective material in healthy aging (Carson et al., 2016; Genon et al., 2014; Glisky & Marquine, 2009; Gutchess et al., 2007; Leblond et al., 2016; Mueller et al., 1986; Rosa et al., 2015; Rosa & Gutchess, 2013), and many study authors have speculated about the longevity of the effect, however this is the first study to establish that the SRE pattern remains for trait adjective material following a one-week delay. Though the SRE remained apparent at follow-up testing, the low overall recognition memory for trait adjectives following the delay made it difficult to determine whether the SRE continues to benefit memory to a level that shows appreciable evidence for intervention viability. For this reason, the investigation of narrative material was a crucial aspect of the current study.

The SRE for Narrative Information Following a One-Week Delay

Examining whether the SRE for narrative information remained apparent following a one-week delay in healthy aging was most informative in terms of determining whether the SRE represents a viable strategy for individuals with memory difficulties/impairment. As discussed above, narrative information is meaningful, structured, and more ecologically valid than single trait adjective words; making it a relevant target for improvement with the SRE, especially for individuals who exhibit episodic memory decline. The present study showed that narrative material is well maintained through use of the SRE following a one-week delay in healthy aging, particularly when retrieval support is provided (i.e., on a recognition test). Though there was a decrease in overall recognition memory, performance following the delay indicated maintained benefit for self-referential processing. These results are more telling than those of the trait adjective paradigm, given that overall memory for narrative information remained relatively accurate following the delay (unlike for trait adjectives, which showed a maintained SRE but very low overall scores at follow-up). It is notable, however, that the benefit of self-referential processing disappeared at follow-up testing when participants were administered a cued recall test of narrative details. It is thus apparent that the SRE presents for narrative information following a delay only under circumstances of high retrieval support (such that is provided on a recognition test). Nonetheless, it is promising that the SRE continues to benefit memory for real-world narrative information after a one-week delay in healthy aging, and this study is the first to document the maintained benefits across time for narrative material and in those experiencing episodic memory decline.

The SRRE Following a One-Week Delay

Recollection is a process that declines in healthy cognitive aging (Bastin & Van der Linden, 2003; Java, 1996; Light, Prull, La Voie, & Healy, 2000; Mäntylä, 1993) and the SRRE has been found to improve recollection in this population, for both trait adjective (Carson et al., 2016; Genon et al., 2014; Leshikar et al., 2015) and narrative (Carson et al., 2016) material. However, whether self-referential processing continues to benefit recollection over a prolonged period of time has been unstudied until the present experiment. Results from the trait adjective paradigm indicated that the SRRE remained apparent following a one-week delay, however overall recollection at follow-up was low. The appearance of the SRRE for trait adjectives following a delay was consistent with studies by Conway and colleagues (1995; 2001), who found the effect following one-hour and 24-hour delays in young adults. Familiarity scores showed a similar pattern, with self-referential encoding benefitting familiarity at both initial and follow-up sessions, however scores at follow-up were low.

An investigation of the SRRE for narrative information provided a stronger indication of the maintenance of the effect following a one-week delay, given that overall recollection "remember" scores remained relatively high at follow-up (thus interpretation was not confounded by potential floor effects as in the trait adjectives). Though overall recollection declined by the second test session, the maintained relatively high scores provides evidence that self-referential processing indeed continues to enhance recollection for narrative information in healthy aging following a one-week period. Unfortunately, the low number of "know" button presses indexing Familiarity during the narrative recognition test prohibited the further analysis of familiarity; however this did not impede the main goal of investigating recollection over the two time points. Results of this study, especially those of the narrative paradigm, indicate the SRE effectively improves recollection in healthy aging, and that this benefit continues to be apparent following a one-week delay.

These results may be explained by Conway & Pleydell-Pearce's (2000) theory of the *self-memory system*, which "consists of a complex hierarchical set of currently active goals (the working self) through which new experience is encoded into the autobiographical knowledge base" (Conway et al., 2001, p. 683). According to Conway et al. (2001), self-referential information is integrated over time into the autobiographical memory knowledge base, which triggers recollective experience at retrieval. Information that is low in self-reference (such as that encoded in semantic or structural encoding conditions), however, remains part of the working self and becomes decontextualized as time elapses, thereby leading to lower levels of recollective experience at retrieval.

Effects of Valence on the SRE and SRRE Following a One-Week Delay

Certain research on emotional valence and memory suggests that older adults show a bias towards memory for positively valenced material (e.g., Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005), however, other studies do not support the idea of an age-related positivity bias (Denburg et al., 2003; Grühn et al., 2005; Fernandes et al., 2008; Kensinger et al., 2002; Murphy & Isaacowitz, 2008). Though many of the studies of the SRE in healthy aging have hypothesized that healthy older adults would show a unique bias in memory for positive material, this hasn't necessarily been the case (Carson et al., 2016; Gutchess et al., 2007; Glisky & Marquine, 2009; Leblond et al., 2016; Leshikar et al., 2015). Similar to Experiments 1 and 2 of the current dissertation, Experiment 3 found no influence of valence on the SRE when memory for trait adjectives and narrative information was testing using a recognition memory task. However, also consistent with Experiment 2, enhanced memory for negatively valenced narrative information was evident when memory was tested with a cued recall test. It has been suggested that when retrieval tasks are more demanding, effects of valence are more likely to become apparent (Murphy & Isaacowitz, 2008; D'Argembeau et al., 2005). This was proven to be the case when comparing the influence of valence found on the more demanding recall vs. recognition tests in Experiment 2 and the current experiment. However, it was additionally hypothesized that if retrieval difficulty influenced the appearance of valence effects, the recognition tests at follow-up would show an influence of valence, given that retrieval of material would be more difficult following a one-week delay. Results did not support this idea; instead effects of valence continued to be absent on tests of recognition memory of both trait adjectives and narrative information. Similar to Experiments 1 and 2, effects of valence were limited to false alarms, with more positive than negative distractors endorsed as studied. These findings may be explained by evidence that positive information is remembered in a more gist-like, general fashion making it more difficult to distinguish between studied and distractor items (Kensinger, Garoff-Eaton, & Schacter, 2007).

The analysis of "remember" scores for trait adjectives indicated enhanced recollection for positive over negative words that was unique to the self-reference condition. These results are consistent with those of Leshikar et al. (2015), who also found better recollection for positive trait adjectives encoded self-referentially in healthy aging. Though this study found that recollection for trait adjectives encoded semantically was higher for negatively valenced words, the present experiment did not find valence effects on recollection for trait adjectives encoded either semantically or structurally.

The analysis of "remember" scores for narrative information found enhanced recollection for negatively valenced narrative details. These results are consistent with past research that showed better cued recall for negatively valenced narratives than positive, in healthy young and older adults (Carson et al., 2016). Recollection has been shown to be instrumental in recall performance (Yonelinas, 2002), thus it may be unsurprising that similar to the results of the narrative cued recall test, recollection was higher for negatively valenced material. Additionally, enhanced recollection for negatively valenced narrative details is consistent with research that has indicated that detailed memory for negative information is associated with recollection, while gist-like memory for positive information is associated with familiarity (Mickley & Kensinger, 2008). Furthermore, memory for details of events, inherent in recollection, has been found to be more accurate for negative versus positive events across the healthy cognitive lifespan (Bohn & Berntsen, 2007; Levine & Bluck, 2004; Kensinger & Schacter, 2006) and is especially apparent in the re-experiencing of flashbulb memories (Davidson, Cook, & Glisky, 2006; Kensinger, Krendl, & Corkin, 2006; Wolters & Goudsmit, 2005).

Conclusions

Though the applicability of the SRE strategy to individuals facing episodic memory decline or impairment has been suggested in multiple studies, there have been no investigations of the benefits of the SRE in these populations after a prolonged period of time. Experiment 3 examined the SRE following a one-week delay in healthy aging for both trait adjective and narrative material. It was found that both types of material continued to show the SRE at follow-up study, particularly when retrieval support was provided at test. Furthermore, self-referential processing continued to enhance recollection for trait adjectives and narrative material following the delay. The benefits of the SRE and the SRRE were especially apparent for narrative information, which is significant given the ecological validity of this type of material and the declines in memory seen for narrative information in healthy aging. This study is the first to provide concrete evidence that the SRE represents a viable intervention strategy for individuals with episodic memory difficulties, with prolonged effects that continue to benefit memory at one-week follow-up. Future studies are necessary to specifically test the SRE in a randomized-controlled format, in order to verify the potential of the SRE as a behavioural intervention for memory.

CHAPTER 5

Experiment 4: The Maintenance of the SRE for Narrative Information in aMCI

Experiment 3 established that the SRE promoted memory following a one-week delay in healthy aging, particularly for narrative information. Given these promising results, an important next step was to examine whether the SRE also enhances memory over an extended period of time in populations experiencing more severe episodic memory decline, such as those with aMCI. As mentioned above, individuals with aMCI experience notable memory decline for narrative information (Belleville et al., 2006; Cunje, Molloy, Standish, & Lewis, 2007; Hua et al., 2008; Nordlund et al., 2005; Wang & Zhou, 2002), and these deficits extend to autobiographical episodic memory, memory for past personal episodes (Barnabe et al., 2012; Gamboz et al., 2010; Murphy et al., 2008). Building on Experiment 3, the purpose of Experiment 4 was to examine whether self-referential processing improved memory for narrative information following a one-week delay in aMCI. Previous studies suggested that the SRE may provide an intervention strategy for improving memory in clinical populations (Grilli & Glisky, 2010, 2011, 2013; Grilli & McFarland, 2011), however the present study was the first to examine the maintenance of the SRE in aMCI in a follow-up test session. It was predicted that: (a) those with aMCI would show a maintained SRE for narrative recognition across the two time points (initial and follow-up session), however overall memory would likely decrease at the second time point; (b) since individuals with aMCI did not show a self-referential advantage over and above that of semantic processing for narrative cued recall (Experiment 2), it was hypothesized that an effect of "deep encoding" would persist at follow-up; (c) given that self-referential encoding showed an equivalent "deep encoding effect" to semantic processing in promotion of recollection in aMCI at initial testing, it was predicted that an effect of "deep encoding" would similarly be found at follow-up testing; (d) if valence preferences were shown, they were predicted to be in the direction of a negativity bias, particularly on the test of cued recall.

Methods

Participants

The same sample of 20 individuals with aMCI (age: *M*=72.7, *SD*=5.7) and 30 healthy older adult controls (age: *M*=70.1, *SD*=5.5) tested in the previous experiments participated in Experiment 4. All participants completed cognitive testing with a standard battery of neuropsychological tests (described in Experiment 1, p. 26). For further detail regarding recruitment and classification of aMCI, see Experiment 1 pages 25-26.

Procedure

The experiment occurred over two sessions, approximately one week apart. During the initial study and test session, participants were administered the narrative paradigm described in Experiment 2. The follow-up test session (Experiment 4), which occurred approximately one week following the initial study session, involved the re-testing of memory for narrative material using the same tests employed in Experiment 2.

Study and Test Session #1 (Initial Session)

Narrative paradigm. The narrative paradigm administered was identical to the ones described in Experiments 2 and 3. The paradigm is briefly reviewed here; however please see Experiment 2, p. 49 for a more detailed description.

Procedure. Participants made yes / no judgments about 36 narratives under three blocked study conditions, self-reference, semantic, and structural. Each block of self-reference condition trials began with an instruction screen stating, “As you read the following stories, imagine that you are the person who actually experienced the event and is telling the story. Ask yourself, ‘Can

I easily imagine myself experiencing this event?' Press the yellow button for 'yes' and the blue button for 'no'." Subsequently, during each self-reference condition trial, participants were presented with a narrative and the prompt, "Easy to imagine myself?" for which they were asked to make a yes/no button press. Each block of semantic condition trials began with an instruction screen stating, "As you read the following stories, think about the event being described. Ask yourself, 'Does this story describe a positive event?' Press the yellow button for 'yes' or the blue button for 'no'." Subsequently, during each semantic condition trial, participants were presented with a narrative and the prompt, "Positive event?" for which they were asked to make a yes/no button press. Each block of structural condition trials began with an instruction screen stating, "As you read the following stories, count the number of times the word 'the' appears. Ask yourself, 'Does the word 'the' appear more than 3 times?' Press the yellow button for 'yes' and the blue button for 'no'." Subsequently, during each structural condition trial, participants were presented with a narrative and the prompt, "'The' more than 3 times?" for which they were asked to make a yes/no button press. Narratives were presented on a computer screen with E-Prime software (Psychology Tools). Each individual trial began with a fixation cross presented for 500 ms followed by a narrative presented for 20 sec[6], during which time the participant was prompted to make the yes/no judgment. Each trial ended with the presentation of a fixation cross for 5 sec. Reaction time and response type (yes/no) was recorded for each judgment. During a 10-minute retention interval, participants were administered the National Adult Reading Test-Revised (NART-R) and a subtraction task devised by the investigators.

Following the retention interval, a cued recall test was administered, during which participants were asked to recall as many details as possible aloud from each narrative, with the narrative's title serving as a cue. A recognition test was subsequently administered and asked

[6] The duration for which narratives were presented was determined by pilot testing for Carson et al. (2016).

participants to distinguish previously studied narrative details from distractor details (old/new button press). For the recognition test, 36 studied narratives details and 36 distractor details were presented in random order. Half of the distractor details had a similar theme to studied narrative details and half had novel themes. See Experiment 2, Figure 3.2 for examples. When a participant indicated that a narrative detail had been previously studied ("old"), they were asked to make an additional remember/know decision with a button press. The recognition test was self-paced, and responses were recorded.

Test Session #2 (Follow-up Session)

The second session of the experiment occurred approximately one-week following the initial study and test session. During the follow-up test session, memory for narratives studied during the initial study session was once again tested, however participants did not have the opportunity to study the material again at this point.

Narrative cued recall test. Participants completed the same narrative recall test that they were administered during the initial study session (approximately one week prior; Experiment 2). Titles of studied narratives appeared on a computer screen and participants were asked to state aloud any details he/she could recall from that story. Titles appeared in random order, thus they did not appear in the same order as in the initial study session (Experiment 2).

Scoring of narrative cued recall test. As described in Experiment 2, narrative cued recall was scored according to a scoring key created for each narrative in order to standardize scoring between raters. An example of the narrative cued recall scoring procedure is presented in Experiment 2, Figure 3.3 (p.53). Details were accepted if they had the same or equivalent meaning to narrative components (as in Fotopoulou et al., 2008). Details were then tallied according to the condition and valence in which they were initially presented. This allowed comparison of overall recall for narrative information between the three encoding conditions and two valence conditions. Scoring was performed by two independent raters, blind to the allocation of narratives to the study conditions. Inter-rater reliability will be calculated using Pearson's correlation coefficient.

Narrative recognition test. Similar to the recognition test administered during the initial study session, the narrative recognition test of the follow-up session included details from all 36 narratives originally studied. However, the 36 distractor narrative details presented during the recognition test were different than the distractors presented during the first session. Distractor details once again included 18 details with the same theme as the studied narratives details and 18 with themes unrelated to the studied narratives. There were an equal number of positive and negative distractor details presented. When a participant indicated that a narrative detail had been previously studied ("old"), he or she was asked to make an additional remember/know decision with a button press. The recognition test was self-paced, and responses were recorded.

Results

Neuropsychological Testing

Performance on neuropsychological measures is presented in Experiment 1, Table 2.1.

Narrative Cued Recall (SRE)

Inter-rater reliability was calculated using Pearson's correlation coefficient and reliability between raters was high with a coefficient of 0.95. Narrative recall data from 30 healthy controls and 17 individuals with aMCI was analyzed, as three individuals with aMCI did not complete the narrative recall test at the follow-up session (due to the difficulty of the test and individual participant emotional considerations). A 2×3×2×2 (participant group × encoding condition × valence × time) repeated-measures ANOVA revealed a main effect participant group, *F*(1,45)=16.97, *p*<.001, η_p^2=.27, with healthy controls showing significantly higher recall than the aMCI group. A main effect of condition, *F*(2,90)=33.71, *p*<.001, η_p^2=.43, with planned contrasts, indicated no significant different between narratives encoded in self-reference or semantic conditions, *F*(1,45)=2.43, *p*=.13, η_p^2=.05, but significantly higher recall in the semantic condition than in the structural condition, *F*(1,45)=27.06, *p*<.001, η_p^2=.38. A main effect of valence, *F*(1,45)=62.89, *p*<.001, η_p^2=.58, revealed higher recall for negative than positive details. A main effect of time was found, *F*(1,45)= 159.45, *p*<.001, η_p^2=.78, indicating significantly higher recall scores at the initial test session than the follow-up session. A significant interaction between encoding condition and time was found, *F*(2,90)=16.95, *p*<.001, η_p^2=.27, and pairwise comparisons indicated that while cued recall showed a trend towards significance when comparing the self-reference and semantic conditions during the initial study session (*p*=.09), this comparison was highly non-significant at the follow-up session (*p*=.99). The comparison between semantic and structural conditions was significant at both time points (ps≤.001). A trend towards significance was also revealed for the encoding condition × participant group, *F*(2,90)=2.53, *p*=.09, η_p^2=.05, with subsequent analyses indicating that while the healthy control group showed significantly higher recall for the semantic condition over the structural condition (*p*<.001), the aMCI group showed only a marginally significant difference between these conditions (*p*=.07). A (marginally) significant time × participant group interaction, *F*(1,45)=3.93, *p*=.054, η_p^2=.08, revealed that the difference in cued recall score was greater between healthy controls and individuals with aMCI at the initial test session (mean difference=.08, *p*<.001) than at the follow-up session (mean difference=.11, *p*=.001). A significant encoding condition × valence interaction, *F*(2,90)=3.45, *p*=.04, η_p^2=.07, indicated no significant difference between the self-reference and semantic conditions for positively valenced narratives (*p*=.99) but higher cued recall for self-referenced versus semantically encoded narratives that were negatively valenced (*p*=.03). The difference between semantic and structural conditions were not influenced by the valence of narratives (both positive and negative *p*<.001). Last, a significant interaction between valence and time, $F(1,45)=6.04$, $p=.02$, $\eta_p^2=.12$, showed that though they were both significant at p<.001, the mean difference between negative versus positive narratives was greater at the initial test session (mean difference=.06) than at the follow-up session (mean difference=.04). There was no significant interaction between valence and participant group, $F(1,45)=.01$, $p=.99$, $\eta_p^2=.001$. See Figure 5.1 for narrative cued recall scores.

Narrative Recognition (SRE)

Narrative recognition scores were calculated by subtracting the proportion of false alarms from the proportion of hits, resulting in a "corrected recognition" score. Each participant had a single false alarm rate across study conditions. See Table 5.1 for uncorrected scores. A 2×3×2×2 (participant group × encoding condition × valence × time) mixed ANOVA revealed a main effect of group, $F(1,48)=20.87$, $p<.001$, $\eta_p^2=.30$, with healthy controls showing overall more accurate corrected recognition than individuals with aMCI. A main effect of condition was additionally found, $F(2,96)=89.47$, $p<.001$, $\eta_p^2=.66$, with planned contrasts indicating enhanced

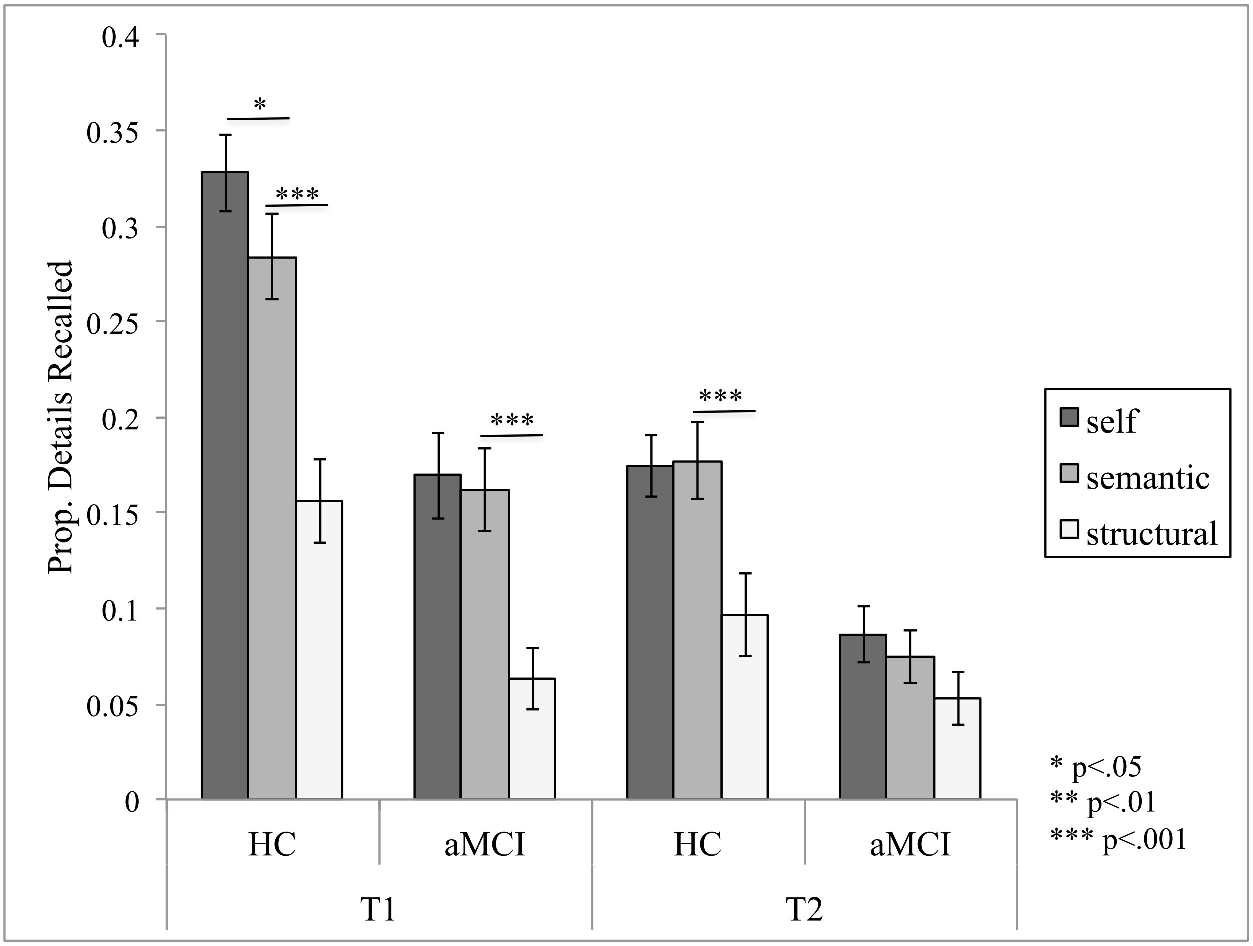

Figure 5.1. Narrative cued recall scores, as a function of participant group, encoding condition, and time. T1=time 1 (initial session); T2= time 2 (follow-up session). HC=healthy control; aMCI=amnestic Mild Cognitive Impairment. Error bars represent standard error.

memory for narrative details encoded in the self-reference condition over the semantic condition, $F(1,48)=9.83$, $p=.003$, $\eta_p^2=.17$, and enhanced memory for narrative details encoded in the semantic condition over the structural condition, $F(1,48)=96.42$, $p<.001$, $\eta_p^2=.67$. No main effect of valence was revealed, $F(1,48)=.21$, $p=.65$, $\eta_p^2=.004$. A main effect of time was revealed, $F(1,48)= 82.30$, $p<.001$, $\eta_p^2=.63$, indicating that corrected recognition scores were significantly lower at the follow-up test session than at the initial session. A significant interaction between encoding condition × time was found, $F(2,96)=16.19$, $p<.001$, $\eta_p^2=.25$, and subsequent pairwise comparisons, indicated that while there was a significant advantage to recognition memory for self-referenced narratives over semantically encoded narratives during the initial test session ($p=.01$), this advantage disappeared at follow-up ($p=.20$). A significant advantage for semantic over structural encoding was apparent at both time points (*p*s<.001). Significant interactions were not apparent between participant group and encoding condition, $F(2,96)=.54$, $p=.58$, $\eta_p^2=.01$, condition and valence, $F(2,96)=.27$, $p=.76$, $\eta_p^2=.006$, or between valence and time, $F(1,48)=2.14$, $p=.15$, $\eta_p^2=.04$. See Figure 5.2 for corrected recognition performance across the two time points.

False alarms. Scores are presented in Table 5.1. Proportion of false alarms (distractor narrative details endorsed as "old") was analyzed in a 2×2×2 mixed ANOVA (participant group × valence × time). A main effect of participant group, $F(1,48)=7.40$, $p=.009$, $\eta_p^2=.13$, showed that the aMCI group made more false alarms then their healthy counterparts. A main effect of time, $F(1,48)=28.17$, $p<.001$, $\eta_p^2=.37$, revealed that more false alarms were made at the follow-up session that at the initial test session, across participant groups. Additionally, a marginal main effect of valence, $F(1,48)=3.78$, $p=.06$, $\eta_p^2=.07$ indicated a propensity towards making false alarms for positive details across time points and participant groups. No significant interactions were found between valence and participant group, $F(1,48)=.04$, $p=.84$, $\eta_p^2=.001$, time and participant group, $F(1,48)=1.59$, $p=.21$, $\eta_p^2=.03$, or between time and valence, $F(1,48)=.03$, $p=.86$, $\eta_p^2=.001$.

Table 5.1

Narrative Recognition and Recollection "Remember" Scores Over One-Week in Healthy Aging and aMCI

			Hits						False Alarms	
			Self-Reference		Semantic		Structural			
	Group	Time	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Overall Recognition	HC	T1	.87 (.13)	.88 (.14)	.82 (.16)	.83 (.14)	.44 (.27)	.49 (.27)	.10 (.08)	.08 (.07)
		T2	.75 (.23)	.80 (.12)	.74 (.19)	.67 (.20)	.53 (.29)	.49 (.25)	.17 (.10)	.14 (.15)
	aMCI	T1	.81 (.16)	.70 (.19)	.72 (.22)	.66 (.20)	.38 (.27)	.39 (.26)	.16 (.17)	.13 (.12)
		T2	.70 (.22)	.56 (.30)	.61 (.23)	.60 (.24)	.48 (.32)	.38 (.21)	.27 (.22)	.26 (.18)
Recollection "Remember" Scores	HC	T1	.68 (.27)	.72 (.27)	.63 (.31)	.59 (.29)	.24 (.27)	.32 (.28)	.04 (.05)	.03 (.04)
		T2	.48 (.31)	.54 (.29)	.43 (.26)	.43 (.27)	.23 (.22)	.28 (.24)	.08 (.09)	.05 (.09)
	aMCI	T1	.65 (.22)	.61 (.25)	.60 (.29)	.52 (.32)	.25 (.23)	.28 (.27)	.09 (.13)	.09 (.11)
		T2	.37 (.26)	.35 (.28)	.33 (.30)	.36 (.28)	.23 (.26)	.22 (.27)	.10 (.16)	.10 (.15)

Note. Values represent means (standard deviations). T1=time 1 (initial session); T2=time 2 (follow-up session); Pos=positive; Neg=negative; HC=healthy controls; aMCI=amnestic Mild Cognitive Impairment.

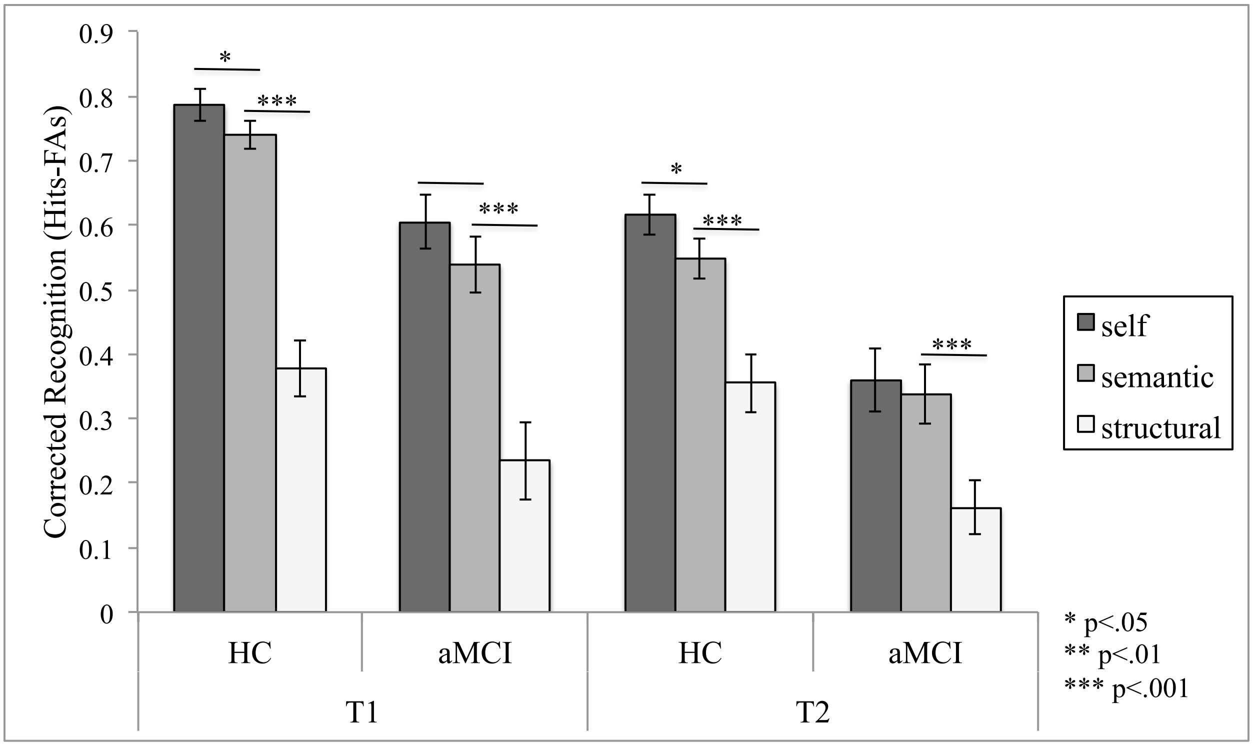

Figure 5.2. Narrative corrected recognition scores indicating recognition memory accuracy, as a function of participant group, time, and encoding condition. T1=time 1 (initial session); T2=time 2 (follow-up session); HC=healthy controls; aMCI=amnestic Mild Cognitive Impairment. Error bars represent standard error.

Narrative Recollection (SRRE)

Experiences of recollection and familiarity during the recognition test were measured using a remember (recollection)/ know (familiarity) button press. Scores were then calculated with the Independence Remember Know (IRK) method (Jacoby, Yonelinas, & Jennings, 1997; Yonelinas & Jacoby, 1995). Recollection scores were calculated for each study condition according to corrected recognition [proportion remember hits – proportion remember false alarms]. See Table 5.1 for uncorrected scores. As in Experiment 2, there were few "know" button presses made indicating Familiarity in either healthy control or aMCI group, and this prevented further analysis of familiarity scores. Though unfortunate, this did not impede the main goal of studying recollection across time points.

A 2×3×2×2 (participant group × encoding condition × valence × time) mixed ANOVA of recollection scores revealed a main effect of group, $F(1,48)=5.91$, $p=.02$, $\eta_p^2=.11$, with healthy controls showing higher recollection than individuals with aMCI across time points. A main effect of condition was revealed, $F(2,96)=58.07$, $p<.001$, $\eta_p^2=.55$, with self-referential encoding enhancing recollection over semantic processing, $F(1,48)=6.82$, $p=.01$, $\eta_p^2=.12$ and semantic processing improving recollection over structural encoding, $F(1,48)=58.06$, $p<.001$, $\eta_p^2=.55$. A main effect of time, $F(1,48)=50.53$, $p<.001$, $\eta_p^2=.51$, indicated that recollection was higher at the initial test session than at follow-up testing. There was no main effect of valence revealed, $F(1,48)=.96$, $p=.33$, $\eta_p^2=.02$, however, a trend towards an interaction between participant group and valence, $F(1,48)=2.99$, $p=.09$, $\eta_p^2=.06$, indicated that while healthy controls showed significantly higher "remember" scores for negative versus positive details ($p=.04$), the aMCI showed no difference in recollection attributed to valence. A significant interaction between encoding condition and time, $F(2,96)=21.77$, $p<.001$, $\eta_p^2=.31$, revealed that while there was a significant advantage to recollection for self-referenced narratives over semantically encoded narratives at the initial test session ($p=.04$), this advantage did not persist at follow-up ($p=.22$). The advantage to recollection for semantically encoded narratives over those that were structurally encoded was evident at both time points (ps<.001). No significant interaction was found between participant group and encoding condition, $F(2,96)=1.26$, $p=.29$, $\eta_p^2=.03$, participant group and time, $F(1,48)=.31$, $p=.58$, $\eta_p^2=.006$, encoding condition and valence,

$F(2,96)$=.94, p=.34, η_p^2=.02, or valence and time, $F(1,48)$=.77, p=.38, η_p^2=.02. Recollection "remember" scores, calculated according to corrected recognition, are presented in Figure 5.3.

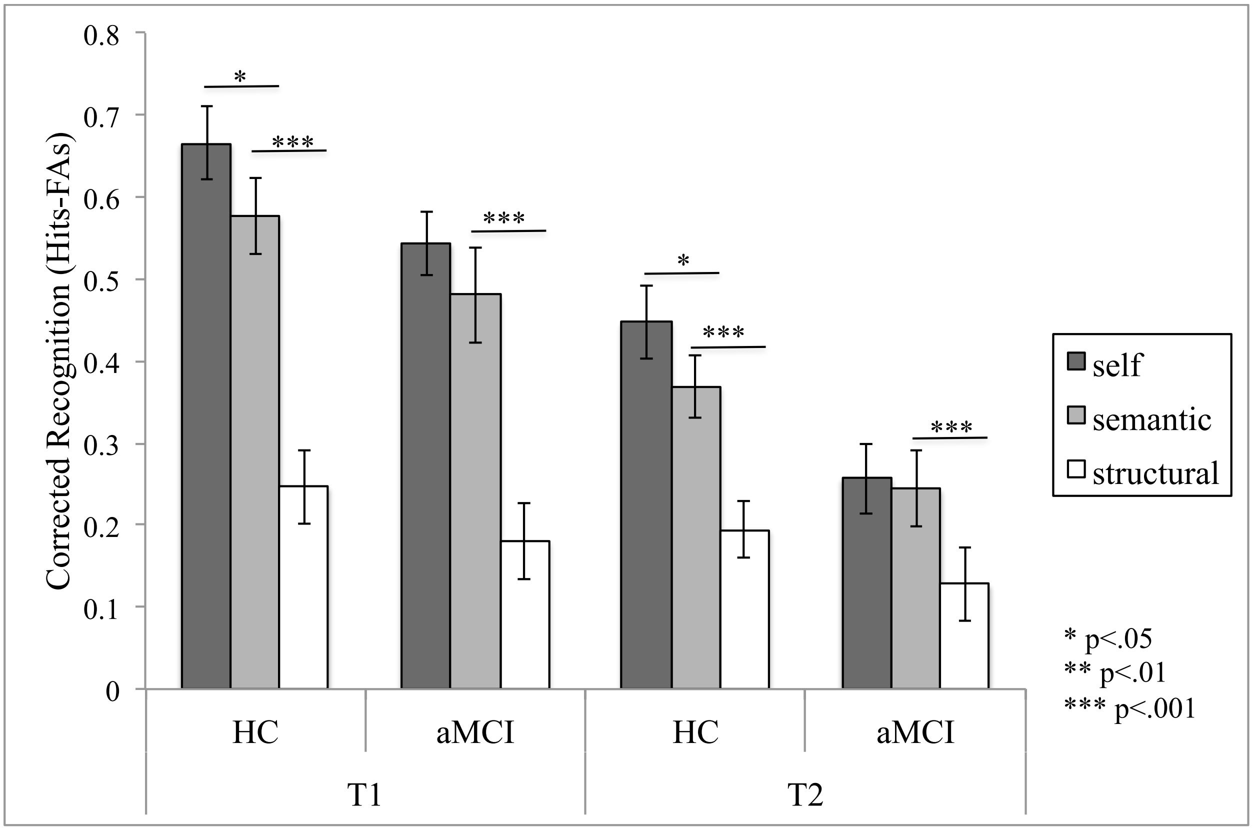

Figure 5.3. Narrative corrected recognition, indicating recollection "remember" scores, as a function of participant group, encoding condition, and time. T1=Time 1 (initial session); T2=Time 2 (follow-up session); HC=healthy controls, aMCI=amnestic Mild Cognitive Impairment. Error bars represent standard error.

Discussion

Building on the first three studies of the present dissertation, Experiment 4 was the first to investigate whether the SRE and SRRE for narrative information would be found in aMCI following a one-week delay. While the SRE enhanced memory for narrative memory at initial testing, after a one-week delay, no significant advantage was found for self-referenced over semantically encoded narrative information. This effect of "deep encoding" in general at follow-up testing was shown on both tests of narrative cued recall and recognition. Similarly, recollection was enhanced by "deep encoding" in aMCI, with self-referenced and semantically encoded narratives showing similar levels. Valence effects were limited to the narrative cued recall test, which showed enhanced memory for negatively over positively valenced details. The following is a more specific discussion of the results described above.

The SRE for Narrative Information Following a One-Week Delay in aMCI

Experiment 2 indicated that the SRE for narrative information was found in aMCI on a test of recognition memory but not on a test of cued recall, with the latter showing a "deep encoding" effect in general. Experiment 4 investigated how these effects fare over time in aMCI. Results indicated that following a one-week delay, self-referential encoding promoted memory for narrative information to the same extent as semantic encoding. Thus, while the SRE was no longer found at follow-up testing, "deep encoding" processes continued to enhance memory for narrative information in aMCI. These results were apparent on both tests of narrative cued recall and recognition, though memory was overall better on the recognition test.

In Experiment 1 of the current dissertation, an SRE for trait adjectives in aMCI was not found, which was contrary to the results of one of the few studies of the SRE for trait adjectives in aMCI, which found an SRE for positive information (Leblond et al., 2016). One reason for this discrepancy that was raised in the Discussion section of Experiment 1 is that while the SRE may be immediately shown, the effect may fade quickly in aMCI. This was the case in the Leblond et al. study when a recognition test was administered immediately following study, but not in Experiment 1 when the recognition test was preceded by a 10-min. retention interval. Perhaps the impact of time on the SRE for narrative information in aMCI is similar here. At initial testing, an SRE was apparent on a test of narrative recognition, however by one-week follow up, this effect had faded to a more general "deep encoding" effect. Though the SRE for narrative information in aMCI may be more resistant to fading than the effect for trait adjectives, self-referential processing does not seem to specifically enhance memory in this population after a prolonged period of time.

The SRRE for Narrative Information Following a One-Week Delay in aMCI

In Experiment 2, it was found that though self-referential processing enhanced recognition memory for narrative information in aMCI, it did not significantly benefit recollection over and above that of semantic processing. The present study examined whether these results would be maintained following a one-week delay. Indeed, following a one-week delay, individuals with aMCI continued to show enhanced recollection for narrative details that were initially studied under conditions of "deep encoding" (whether self-referential or semantic). In accordance with Experiments 1 and 2 of the current dissertation, healthy older adults showed overall higher levels of recollection than their counterparts with aMCI. Though it does not seem that individuals with aMCI show an SRRE, it is encouraging that recollection can still benefit over time from deep encoding processes, especially given that this ability significantly declines in this population (Anderson et al., 2008; Hudon et al., 2009; Irish et al., 2010; Serra et al., 2010; Westerberg et al., 2006).

Influence of Valence Following a One-Week Delay in aMCI

The influence of valence on memory has been suggested to be related to the difficulty of the retrieval task administered, with recall tests more likely to elicit effects of valence than recognition tests (Murphy & Isaacowitz, 2008; D'Argembeau et al., 2005). As in Experiments 2 and 3, this appeared to be the case when comparing tests of narrative cued recall and narrative recognition. The narrative cued recall test showed a main effect of valence, such that negative narrative details were better recalled then positive details, across healthy aging and aMCI groups. However, an interaction between valence and time indicated that the difference in recall for negative over positive details was greater at the initial test session than the follow-up session. Furthermore, an interaction between condition and valence revealed a recall advantage for self-referenced over semantic encoding specifically for negatively valenced details. These findings are contradictory not only to the idea of a positivity bias in aging (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005), but also to the single study that has investigated the SRE in aMCI, which found a positivity bias specific to the aMCI group (Leblond et al., 2016). These results are, however, consistent with those of Experiments 2 and 3 of the current dissertation, which similarly found a significant recall advantage for negative details in both healthy aging and aMCI, and a study by Mah et al. (2017), which found enhanced memory for negative verbal information in aMCI (however, not in healthy aging). In contrast to the narrative cued recall test, the narrative recognition task of the present study did not show a significant effect of valence. These results are consistent with studies of the SRE that have shown an influence of valence on recall but not recognition tests (D'Argembeau et al., 2005) and also with Experiments 2 and 3 of the present dissertation. Consistent with past research on the SRE in healthy aging and aMCI and the three prior studies included in the present dissertation, both groups showed higher false alarms for positively valenced distractors (Carson et al., 2016; Gutchess et al., 2007; Glisky & Marquine, 2009; Leblond et al., 2016). In terms of "remember" scores indexing recollection, a marginal interaction between participant group and valence indicated that while healthy controls showed significantly higher recollection for negative versus positive narrative details, recollection was not influenced by valence in the aMCI group. While future research is needed to further delineate any influence of valence on memory for narrative information in aMCI, the current experiment indicates that this influence is more likely to be in the direction of a negativity effect than a positivity effect.

Conclusions

Experiment 4 is the first study to investigate whether self-referential encoding continues to benefit memory in aMCI following a one-week delay. While "deep encoding" processes (regardless of whether self-referential or semantic) enhanced cued recall and recognition memory of narrative material following a one-week delay, self-referential encoding did not show a specific benefit to memory for narrative information at one-week follow-up. The SRE was not found in aMCI after 1 week; however, the results are encouraging as they clearly demonstrate that memory in aMCI can be enhanced over a prolonged period of time with strategies that capitalize on deep encoding processes. Recollection was similarly improved by deep encoding and not specifically by self-referential processing in aMCI, meaning that a SRRE is not present in this population over time. Effects of valence were limited to the cued recall test, which showed enhanced recall for details of negatively valenced narratives. Further research is necessary to examine the SRE in aMCI. Though the effect seems to be present at initial testing for narrative information, it appears to fade following a delay, with showcased benefits equal to that of semantic encoding.

CHAPTER 6

General Discussion

Previous research has shown that self-referential encoding effectively enhances episodic memory in healthy young and older adults. The four experiments that comprise the current dissertation had two overarching goals: (1) to establish whether the mnemonic benefits of the SRE extend to individuals with aMCI, and (2) to investigate whether gains to memory due to the SRE are maintained over an extended period of time in healthy and pathological forms of cognitive aging (aMCI). Enhanced recollection due to self-referential processing (SRRE) and the influence of material valence on memory were additionally examined in each of the studies. Presented below is a summary of the main findings of the four experiments, how the findings across experiments relate to each other, and theoretical and practical implications of the findings.

Summary of Experiments

Experiment 1 sought to investigate the SRE in healthy aging and aMCI using a commonly employed trait adjective paradigm. Additionally, the SRRE was explored for the first time in aMCI. Results indicated that while healthy older controls exhibited an SRE for trait adjectives, individuals with aMCI did not specifically benefit from self-referential processing, instead showing similar levels of recognition memory in self-reference and semantic encoding conditions. This was thought to represent a "deep encoding" effect. Similarly, though an SRRE was found for healthy controls, recollection for trait adjectives did not specifically improve with self-referential encoding in aMCI, and instead benefitted to the same extent as in the semantic condition. There was no influence of valence on recognition memory for trait adjectives in either the healthy control group or aMCI group.

The purpose of Experiment 2 was to investigate whether the SRE for narrative information, evident in healthy young and older adults, extended to aMCI. Since narrative information is more ecologically valid than single trait adjectives, improvement with self-referential strategies was thought to be more applicable to real-world functioning. The SRRE for narrative information was also examined for the first time in aMCI. Results indicated that both healthy controls and individuals with aMCI showed the SRE on a test of narrative recognition, however when tested with a cued recall test, the aMCI group did not show a benefit from self-referential encoding above and beyond that of semantic encoding. Similarly, recollection for narrative details was enhanced by "deep encoding" processes in general in aMCI, regardless of whether details were encoded through self-referential or semantic processing. While memory for negatively valenced narrative details was higher in healthy aging and aMCI on the cued recall test, no other effects of valence were apparent. Overall, Experiment 2 indicated that individuals with aMCI show an SRE for structured, contextual material, such as narratives, however external support at recognition must be present for this benefit to occur.

Experiment 3 aimed to formally test the suggestion in the SRE literature that deep encoding in general, and self-referential processing in particular, may provide long-term benefits that improve episodic memory in populations facing episodic memory decline, such as in healthy aging. This was the first experiment to test whether the benefits of the SRE are maintained following a one-week delay. Results indicated that the SRE remained present following the delay for both trait adjectives and narrative information when tested using a recognition task, though memory for trait adjectives dropped significantly by follow-up testing. While cued recall of narrative information showed an SRE at initial testing, self-referential encoding did not benefit recall over and above that of semantic processing at follow-up. Interestingly, the SRRE found for trait adjectives and narrative information at initial testing remained at follow-up, indicating that recollection continued to be enhanced by self-referential processing following a delay. Enhanced memory was found for negatively valenced details in the cued recall test and also for recollection of narrative information. Overall, Experiment 3 showed that deep encoding, and in some cases self-referential processing in particular, successfully enhances recognition memory and recollection of both trait adjectives and narrative information in healthy aging, making it a potentially valuable strategy for memory change in this population.

Given findings that self-referential processing continued to improve recognition memory for trait adjectives and narrative information in healthy aging over a one-week period exhibited in Experiment 3, Experiment 4 aimed to investigate whether a clinical population with more notable episodic memory impairment, individuals with aMCI, would likewise show continued benefit from the strategy over time. Results indicated that though individuals with aMCI showed the SRE for narrative recognition at initial testing, following a one-week delay, similar recognition accuracy for narrative details was found regardless of whether narratives were initially encoded in the self-reference or semantic conditions. Narrative cued recall, as well as recollection, showed similar "deep encoding" effects, with similar improvement for material encoded in self-reference and semantic conditions. Effects of valence were limited to the cued recall test, with enhanced recall for details of negatively valenced narratives.

The following discussion integrates the findings of the four experiments to answer the research questions specified above and also comments on the future directions of this research.

Do the Mnemonic Benefits of the SRE and SRRE Extend to Individuals with aMCI?

The SRE for Trait Adjectives and Narratives in aMCI

The research that comprises the current dissertation makes a valuable contribution to the literature on the SRE in aMCI, a topic that has received very limited study. There have been three published studies that have investigated the SRE in aMCI. Rosa et al. (2015) investigated the SRE for trait adjectives, and found that while healthy older adults showed enhanced memory for self-referenced words, individuals with aMCI did not. A second study examining the SRE for trait adjectives by Leblond et al. (2016) found that while healthy older adults showed an SRE for trait adjectives regardless of material valence, individuals with aMCI only exhibited the SRE for positive trait adjectives. A third study, conducted by Rosa et al. (2016), used a more ecologically valid paradigm to study self-related processing in aMCI and showed that while personally performing an action with an item enhanced recognition memory for that object, it did not enhance source memory for that same item.

The current dissertation adds to this limited literature investigating the SRE in aMCI in several ways. First, findings of no SRE for trait adjectives in aMCI and, instead, similar benefits from semantic processing is consistent with Rosa et al. (2015) but inconsistent with Leblond et al. (2016), who found an SRE for positively valenced trait adjectives in aMCI. Though Rosa et al. (2015) did not investigate material valence, Experiment 1 of the current dissertation found that it did not impact recognition memory for trait adjective words in aMCI. The discrepancy between the results of the Leblond et al. study compared to those of Rosa et al. (2015) and the current dissertation may be partly explained by the fact that in Experiment 1 and Rosa et al., recognition memory for trait adjectives was tested following a retention interval that occurred following study, whereas in Leblond et al., recognition was tested immediately following study.

Perhaps this indicates that while an SRE for positive trait adjectives is exhibited in aMCI for a short duration, the effect fades very quickly.

One of the most meaningful contributions of the research included in the current dissertation is the examination of the SRE for ecologically valid narrative information in both healthy aging and aMCI. While trait adjective paradigms are most commonly employed in studies of the SRE, they are not very informative about how the SRE can be used to improve memory for information with real-world applications, such as narrative information. Experiment 2 indicated that memory for narrative information can be improved in both healthy aging and aMCI using self-referential strategies. This is arguably a more important finding than the lack of an SRE for trait adjectives in aMCI, given the ecological validity of narrative information. It is also consistent with the finding from the one other SRE study in aMCI using an ecologically valid paradigm (Rosa et al., 2016), which found that individuals with aMCI showed better recognition memory for objects with which they personally interacted. Further, a notable aspect of aMCI is a decline in autobiographical episodic memory, memory for past personal events (Barnabe et al., 2012; Gamboz et al., 2010; Murphy et al., 2008). Given that memory for narrative information is an integral part of autobiographical episodic memory, and the success seen in the current research for improving narrative memory in aMCI, perhaps the SRE constitutes a beneficial intervention tool for maintaining autobiographical episodic memory in aMCI. The SRE indeed has promising applications in aMCI that build on its effectiveness seen for narrative information.

The SRRE for Trait Adjectives and Narrative Information in aMCI

Recollection declines in healthy aging (Bastin & Van der Linden, 2003; Java, 1996; Light, Prull, La Voie, & Healy, 2000; Mäntylä, 1993) and even more notably in aMCI (Anderson et al., 2008; Hudon et al., 2009; Irish et al., 2010; Serra et al., 2010; Westerberg et al., 2006). Previous studies have shown that self-referential processing enhances recollection (the SRRE) in healthy young (Conway & Dewhurst, 1995; Conway et al., 2001; Leshikar & Duarte, 2012; van den Bos et al., 2010) and older adults (Carson et al., 2016; Genon et al., 2014; Leshikar et al., 2015), and even in those with Alzheimer's disease (Kalenzaga & Clarys, 2013; Kalenzaga et al., 2013; Lalanne et al., 2013). The current research is the first to examine the SRRE in individuals with aMCI for trait adjectives and narrative information. Across Experiments 1, 2, and 4, individuals with aMCI did not exhibit increased recollection for self-related material (either trait adjectives or narratives), instead showing similarly enhanced recollection for material encoded through either self-referential or semantic processing. Thus, they did not show an SRRE, but an effect of "deep encoding" in general. This was surprising given that, as mentioned above, past studies have found the SRRE in Alzheimer's disease. However, as discussed in Experiment 1, methodological differences may underlie this discrepancy, since the studies of the SRRE in Alzheimer's disease did not correct for the impact of false alarms on recognition memory, which can produce misleading results (Leblond et al., 2016). The current findings are, however, consistent with those reported by Rosa et al. (2016), who showed that those with aMCI did not exhibit enhanced source memory for self-referenced items, with recollection processes thought to be integral to source memory (Dulas et al., 2011; Leshikar & Duarte, 2012, 2014; Leshikar et al., 2015). Despite the case that individuals with aMCI do not appear to show benefit to recollection with self-referential processing specifically, it is promising that they still show enhanced recollection when information is processed using "deep encoding" strategies, regardless of whether they are self-referential or semantic.

Influence of Valence on the SRE

Previous research on socioemotional selectivity theory has suggested that older adults exhibit enhanced memory for positively valenced material, due to emotional regulation that emphasizes positive experiences (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005). Other studies have not found a positivity bias specific to older adults (Denburg et al., 2003; Grühn et al., 2005; Fernandes et al., 2008; Kensinger et al., 2002; Murphy & Isaacowitz, 2008), including studies investigating the SRE in healthy aging (Carson et al., 2016, Experiment 2; Glisky & Marquine, 2009; Gutchess et al., 2007; Leblond et al., 2016). The influence of material valence on memory in aMCI has received little study and has produced mixed results, with some studies suggesting a positivity bias (Brueckner & Moritz, 2009; Werheid et al. 2010) and another recent study showing enhanced memory for negative information in aMCI (Mah et al., 2017). The only published study to investigate the influence of valence on the SRE in aMCI showed an SRE specific to positive trait adjective words in this population (Leblond et al., 2016).

The current dissertation built on the limited research investigating the influence of valence on the SRE in aMCI and found no evidence of a positivity bias, except in the case of higher false alarms made on recognition tests for positively valenced information. Otherwise, corrected recognition scores indicated no influence of valence on memory in either healthy aging or aMCI. Interestingly, tests of narrative cued recall administered in Experiments 2, 3, and 4 all showed enhanced memory for negative details in healthy aging and aMCI. These findings are consistent with suggestions by Murphy and Isaacowitz (2008) that the more difficult the retrieval circumstances, the more likely that effects of valence will become apparent (e.g., recall tests are more likely to show effects of valence than recognition tests). These findings are also consistent with D’Argembeau et al. (2005), who specifically compared the influence of valence on the SRE when testing with recall versus recognition tasks and found effects of valence only on recall (though these were indicative of a positivity bias). Not only may type of memory task influence whether valence influences the SRE, the type of stimuli used may also effect whether there is an influence of valence and if so, whether it is in the direction of a positivity bias. Similar to the current research, Carson et al. (2016) found enhanced memory for negative narrative details on cued recall in healthy young and older adults. Enhanced memory seen for negative narrative details on cued recall tests in the current research may be associated with the adaptive value of learning about potentially negative events and how they can be avoided. Accordingly, past research has shown that negative events are indeed remembered with more specific detail than positive events (Bohn & Berntsen, 2007; Levine & Bluck, 2004; Kensinger & Schacter, 2006; Kensinger, 2009; Kensinger et al., 2007). Overall, the present research adds further support that there is no positivity bias specific to older adults on tests of the SRE. Valence effects were not apparent on recognition tests, regardless of the type of stimuli used. Furthermore, where valence effects did occur (on tests of narrative cued recall), both healthy older adults and individuals with aMCI showed a similar propensity towards memory for negatively valenced information. Valence has been shown in some cases to influence memory in aMCI, however it seems that these effects are variable. In addition to valence, there are other factors to take into account that may impact the ability of self-referential processing to enhance memory in aMCI.

Does the SRE Continue to Improve Memory Over a One-Week Delay?

A suggestion made by many studies of the SRE is that the technique could potentially be used as an intervention to improve episodic memory in populations experiencing normal age-related memory decline and in those with pathological forms of memory loss. However, to date, no study has investigated whether benefits to memory seen with self-referential processing are maintained beyond a single study-test session administered within the same day. The current research is the first to examine the longevity of the SRE in healthy aging (Experiment 3) and aMCI (Experiment 4) by testing whether the effect was maintained following a one-week delay.

The SRE as a Potential Memory Intervention in Healthy Aging

Results of Experiment 3 indicated that the SRE continued to be found in healthy aging following a one-week delay, most notably for narrative information (though memory for trait adjectives maintained the effect). Not only did self-referential processing continue to enhance overall memory after an extended period of time, but recollection processes similarly continued to benefit from the effect following the delay (i.e., the SRRE). These results are very promising for considering the SRE as an intervention that can be employed to improve episodic memory, and specifically recollection, in healthy aging.

The investigation of interventions for memory decline associated with healthy aging has become a popular area of research (Yassuda & Nunes, 2009). Though there is a range of mnemonic techniques taught by different memory intervention programs, many programs focus on specific strategies that have been shown to enhance memory, such as rehearsal, categorization, association, imagery, and concentration (reviewed in Gross et al., 2012). One established memory intervention program for healthy aging, called the Memory and Aging Program (Troyer, 2001; Vandermorris et al., 2017; Wiegand et al., 2013), includes teaching of evidence-based semantic processing techniques (Craik & Lockhart, 1972; Preiss, Lukavsky, & Steinova, 2010; Troyer et al., 2006) in the repertoire of mnemonic strategies. Similar to these semantic processing strategies, the basis of the SRE is the Depth of Processing approach (Craik & Lockhart, 1972; Craik & Tulving, 1985), which shows that "deeper" processing at encoding results in better memory at retrieval. It is established across SRE studies that self-referential processing benefits memory to an even greater extent than semantic encoding. The present research furthered these findings by showing that the self-referential processing continues to benefit memory in healthy aging following a one-week delay. These findings emphasize that the SRE represents a useful mnemonic strategy in healthy aging that is likely even more effective than the semantic encoding strategies currently taught in memory intervention programs. This is an important contribution to the literature that examines potential memory interventions for normal age-related memory decline and indicates that the SRE should be further studied using a randomized controlled study design, to confirm its effectiveness as a mnemonic tool in healthy aging.

The SRE as a Potential Memory Intervention in aMCI

Though the current research indicated an SRE for episodic memory in general, and recollection in particular, following a one-week delay in healthy aging, the presence of an SRE in aMCI over time is less clear. While self-referencing showed immediate improvement for narrative recognition memory over and above that of semantic encoding, these effects appeared to fade by one-week follow-up. The initial presence and subsequent fading of the SRE indicated that perhaps individuals with aMCI require booster sessions (shorter intervals during which the intervention is reinforced) to benefit from self-referential processing (Belleville et al., 2008). Though the SRE was found in aMCI for narrative recognition at initial testing, the majority of findings within the current dissertation indicated that self-referencing enhanced overall episodic memory and recollection to the same extent as semantic processing in aMCI. Though individuals with aMCI may not always show a specific benefit for self-referential encoding over and above that of semantic encoding, it is encouraging that memory in this population can still benefit from "deep encoding" strategies in general. Similar to memory intervention programs for healthy aging, programs that focus on intervention in aMCI also teach semantic processing strategies to participants and find them to benefit memory in this population (Troyer et al., 2008). The research of the current dissertation confirms that semantic processing improves episodic memory in aMCI and validates the use of semantic techniques in memory intervention programs for this population. Based on the current research, the use of self-referential strategies in aMCI cannot be as wholeheartedly recommended as in healthy aging. However, while the SRE may somewhat improve episodic memory in aMCI, as was seen for narrative information, the strategy will at the very least provide the same level of benefit as semantic encoding in this population. The ability to make these conclusions about the effectiveness of the SRE in aMCI is due to the methodological strengths of the current research.

Methodological Strengths

Two particular methodological strengths of this research should be noted. The first was the strict characterization of single-domain aMCI. Mild Cognitive Impairment is a heterogeneous condition that encompasses different behavioural manifestations and neuropathological underpinnings (Petersen et al., 2009; 2014; Stephan et al., 2012). Though there have been subtypes of MCI delineated based on whether memory is affected (amnestic versus non-amnestic MCI) and whether cognitive deficits are apparent for more than one thinking ability (single-domain versus multiple-domain MCI), many studies do not differentiate between subtypes of MCI and instead include a general "MCI group" in their research. This is highly problematic, given that subtypes of MCI have been shown to be associated with different forms of neuropathology, with different behavioural manifestations (signifying different neurodegenerative conditions), and different prognoses (Petersen et al., 2009; 2014). The current research included only individuals with single-domain amnestic Mild Cognitive Impairment in the aMCI group. Amnestic MCI is the most common form of MCI and is also highly predictive of underlying Alzheimer's disease neuropathology (Petersen et al., 2006). By including only those with aMCI and ensuring exclusion of comorbidities that could affect memory such as cardiovascular and cerebrovascular conditions, diabetes, and heightened symptoms of mood and anxiety disorders, the current research is informative about a specific patient group that shows high likelihood of progressing to Alzheimer's disease without intervention.

A second strength of the current research was the inclusion of a structural/baseline condition in the trait adjective and narrative paradigms. Many SRE studies compare only self-referential processing to either other-reference or semantic conditions and do not include a baseline condition. Without a baseline condition, it is impossible to know whether participants benefitted from semantic processing, particularly when they do not benefit from self-referential processing. The inclusion of structural (baseline) conditions in the present research crucially showed that while individuals with aMCI did not specifically benefit from self-referential processing in some cases, these individuals were still able to benefit from "deep-encoding" processes inherent in both self-reference and semantic encoding conditions.

Limitations to the SRE in aMCI

The current research showed that encoding items in reference to the self benefits memory in aMCI only for meaningful, structured information, such as narratives, and only when retrieval circumstances provide a great deal of environmental support, such as a recognition test. In contrast to healthy older adults who benefit from self-referential processing of both trait adjectives and narrative material, and who also show enhanced recollection for material encoded self-referentially (i.e., the SRRE), the present research indicates that individuals with aMCI generally exhibit little benefit from self-referential encoding over and above that of semantic processing. One explanation for this finding may be that access to self-related information is more difficult in aMCI than in healthy aging, such that self-referential strategies do not have added benefit in promoting encoding and/or retrieval. Though previous studies have found that personal semantic memory is relatively intact in aMCI (Barnabe et al., 2012; Gamboz et al., 2010; Murphy et al., 2008), others suggest that this ability declines (Leyhe et al., 2009; Irish et al., 2010). Additionally, research shows that there are changes to one's sense of self in aMCI. Leblond et al. (2016) indicated that individuals with aMCI who have awareness of their increased memory difficulties are prone to view themselves more negatively. Other studies have documented changes in self-confidence and feelings of shame and embarrassment when an individual is diagnosed with MCI (Frank et al., 2006; Joosten-Weyn Banningh et al., 2008). A study by Parikh et al. (2016) indicated that individuals with aMCI experienced a pervasive sense of personal inadequacy and a propensity for negative self-evaluation, which was not apparent in healthy aging.

Insight into personal strengths and weaknesses is contingent on access to self-knowledge. Awareness of self-related functioning ranges widely in aMCI, with some individuals showing concern for experienced cognitive and functional changes and others showing relatively little insight (Vogel et al., 2004; Roberts et al., 2009). It has also been suggested that level of anosagnosia (lack of self-awareness of deficits) in aMCI is associated with subsequent progression to Alzheimer's disease (Ries et al., 2007; Spalletta et al., 2014; Tabert et al., 2002). Level of insight may be impacted by multiple factors, including overall cognitive status, language ability, and memory function (Piras et al., 2016). Though original Petersen criteria for MCI (1999, 2001) specified that individuals must have a subjective memory complaint, updated criteria for aMCI (Albert et al., 2011) state that concern about a change in cognition does not necessarily have to be subjective and instead can come from an informant who knows the individual well or a skilled clinician. The presence of anosagnosia in aMCI may indicate a difficulty accessing and updating self-related information in this population.

The idea that individuals with aMCI have greater difficulty accessing knowledge about the self has varying levels of support from the sparse neuroimaging literature investigating self-related processing in aMCI. Past neuroimaging studies on the SRE in healthy populations have identified cortical midline structures, particularly the medial prefrontal cortex and posterior cingulate cortex, as being integral to self-related processing and memory (e.g., Amodio & Frith, 2006; Benoit et al., 2010; Gutchess, Kensinger, & Schacter, 2007; 2010; Kelley et al., 2002; Leshikar & Duarte, 2014; Northoff et al., 2006). A study by Reis et al. (2007) used fMRI to investigate the SRE in healthy aging and MCI and found that cortical midline activity was subtly attenuated for self-appraisal in MCI when compared to healthy controls. Further, this study indicated that activation of cortical midline structures during self-related processing was associated with level of anosagnosia in aMCI. Additionally, studies specifically examining posterior cingulate function in MCI show functional changes in this brain region (Anchisi et al., 2005; Nestor et al., 2003). Though some studies indicate that brain areas critical to the SRE are impacted in aMCI, others show contrary evidence. For example, a study by Zamboni et al. (2013) found that individuals with aMCI activated the medial prefrontal cortex to the same extent as controls when required to answer questions about themselves versus others. Additionally, a recent study by Gaubert et al. (2017) found that while cortical midline structures showed the same level of activation in patients (MCI and Alzheimer's disease) and controls when participants engaged in self-referencing, angular gyrus dysfunction in patients was related to deficits in self-related memory. The neuroimaging literature on the SRE in aMCI is sparse and further research is needed to delineate whether individuals show functional changes to brain areas critical for self-related thought that underlie reduced SRE when compared to healthy controls.

Overall, a potential barrier to the emergence of a SRE in aMCI is this population's difficulty accessing self-related information, possibly due to structural and functional changes to brain regions that are critical for self-related thinking. Anosagnosia exhibited in aMCI is consistent with this idea, however individuals with aMCI range in level of insight into memory difficulties. The research that comprises the current dissertation indicates that individuals with aMCI do not always show a specific benefit from self-referential strategies, however, as exhibited in Experiment 2, improvement with the strategy is possible when material is meaningful and structured and when environmental support is provided at retrieval. While the first two studies of the present dissertation aimed to investigate the SRE in aMCI for different types of information, the latter two studies made an important contribution to the SRE literature by determining whether successes seen with the SRE remain present after a prolonged period of time, in both healthy and pathological aging.

Future Directions

The four studies included in this dissertation provide a valuable contribution to the SRE literature, particularly in terms of documenting the SRE in aMCI and investigating the longevity of the SRE in healthy aging and aMCI. However, findings from these studies raise additional questions that merit study in future research. As mentioned previously, one of the only other studies that has investigated the SRE for trait adjectives in aMCI (Leblond et al., 2016) found an SRE in this population for positive information, whereas in the current research (Experiment 1) no SRE was found and also no effect of valence. It is possible that the trait adjective paradigm used in the current research (which included more stimuli than in Leblond et al.) was too cumbersome for the aMCI group and with a pared down version of the paradigm, the SRE may become apparent.

Another question is whether the SRE exists but is time-limited in aMCI. Leblond et al. (2016) found an SRE for positive trait adjectives in aMCI when testing recognition memory immediately following study of the material. In comparison, Experiment 1 of the current research did not show an SRE for trait adjectives in aMCI when testing recognition memory after a 10-minute retention interval subsequent to study of the material. Perhaps the benefits of self-referential encoding are short-lived in aMCI and perhaps they also depend on the nature of the to-be-learned material. This would explain the presence of an SRE for narrative information in Experiment 2 but the fading of the effect by the follow-up session (Experiment 4). Examination of the time limitations on the SRE in aMCI would inform at which point booster sessions (re-implementation of the intervention) may help to extend the benefit for the strategy in aMCI.

A significant contribution to the SRE literature from this dissertation is the investigation of the SRE for narrative information, which has real-world importance and is more ecologically valid than the single trait adjective words that are most commonly studied in SRE research. Though it is encouraging that self-referential processing effectively enhances narrative information in healthy aging and somewhat in aMCI, it remains to be seen whether the strategy can be applied to material that is even more ecologically valid, such as autobiographical episodic memories. Memory for past personal events declines in healthy aging (Allen et al., 2002; Levine et al., 2002; Nyberg et al., 1996; Piolino et al., 2006; 2009) and aMCI (Barnabe et al., 2012; Gamboz et al., 2010; Murphy et al., 2008). Seeing that narratives can be learned in a self-relevant manner, perhaps this finding can extend to autobiographical episodic memories. For example, individuals could rehearse personally experienced events in a way that emphasizes the self, and any associated perceptions, thoughts, feelings, or contextual elements with the experienced event. This may be more beneficial to memory than recalling events in a more factual and tangential fashion, typical of how healthy older adults (Levine et al., 2002) and individuals with aMCI (Murphy et al., 2008) have been shown to relay autobiographical memories. The SRE shows promise for imroving memory for information that is even more ecologically valid than narratives in general, however future research is necessary to determine whether this can be achieved.

As discussed throughout this dissertation, a crucial future direction of SRE research is to determine its viability as a memory intervention for healthy aging and potentially also for aMCI. While the current research strongly indicates that the SRE has potential as an intervention, particularly in healthy aging, this assertion can only be verified by conducting a randomized controlled trial. Experiment 3 makes a valuable contribution by showing that the SRE benefits narrative memory and that this benefit continues over a prolonged period of time, however these effects cannot be considered an intervention without further rigorous clinical investigation.

Conclusions

The purpose of the current dissertation was to determine whether the Self-Reference Effect (SRE), enhanced memory for self-related information, is present in aMCI, similar to other healthy and memory-disordered populations. Further, the longevity of the SRE was investigated in healthy aging and aMCI. Results indicated that while healthy older adults show a mnemonic advantage for information learned self-referentially, individuals with aMCI exhibit more variable benefits from the SRE that are generally limited to structured, meaningful information (i.e., narratives) and retrieval circumstances with a high level of environmental support (i.e., recognition test format). Furthermore, while the SRE appears to be maintained in healthy aging following a one-week delay, individuals with aMCI seem to benefit equally from semantic processing, particularly following a time-delay. The dissertation findings presented here extend previous research and uniquely contribute to our understanding of the SRE and deep encoding strategies in healthy aging and in aMCI by demonstrating that the SRE: 1) reliably improves episodic memory for narrative information; 2) advantages memory over time in healthy aging; 3) may be dependent on the type of information to be encoded in aMCI; and that 4) deep encoding strategies in general appear to benefit memory over time in aMCI.

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