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Older adults show a self-reference effect for narrative information

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ABSTRACT

The *self-reference effect* (SRE), enhanced memory for information encoded through self-related processing, has been established in younger and older adults using single trait adjective words. We sought to examine the generality of this phenomenon by studying narrative information in these populations. Additionally, we investigated retrieval experience at recognition and whether valence of stimuli influences memory differently in young and older adults. Participants encoded trait adjectives and narratives in self-reference, semantic, or structural processing conditions, followed by tests of recall and recognition. Experiment 1 revealed an SRE for trait adjective recognition and narrative cued recall in both age groups, although the existence of an SRE for narrative recognition was unclear due to ceiling effects. Experiment 2 revealed an SRE on an adapted test of narrative recognition. Self-referential encoding was shown to enhance recollection for both trait adjectives and narrative material in Experiment 1, whereas similar estimates of recollection for self-reference and semantic conditions were found in Experiment 2. Valence effects were inconsistent but generally similar in young and older adults when they were found. Results demonstrate that the self-reference technique extends to narrative information in young and older adults and may provide a valuable intervention tool for those experiencing age-related memory decline.

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Although memory decline is known to be experienced in healthy aging, it is well established that some memory processes are affected more than others. Personal semantic memory is generally shown to be better preserved than autobiographical episodic memory within recall (e.g., Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Piolino et al., 2006; Piolino, Desgranges, & Eustache, 2009) and familiarity better preserved than recollection within recognition (Bastin & Van der Linden, 2003; Java, 1996; Light, Prull, La Voie, & Healy, 2000; Mäntylä, 1993). What if we could capitalise on spared aspects of memory in order to improve those that are more vulnerable to the effects of aging? One way that this may be achieved is through the *self-reference effect* (SRE; Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997), a cognitive phenomenon that has been shown to benefit memory through personal semantic knowledge. In the context of the "levels of processing" effect (Craik & Lockhart, 1972; Craik & Tulving, 1975), self-related processing has been shown to enhance memory to a greater extent than the shallow processing of superficial elements of material (e.g., whether a word is written in capital letters) and even to a greater extent than other forms of deep encoding, such as attending to the meaning of material through semantic processing (Symons & Johnson, 1997). The current study investigates the extent to which the SRE, which relies on a type of memory (knowledge about the self) that remains relatively intact in healthy aging, can serve a compensatory role to improve other types of memory known to decline with age.

The SRE is established as a robust phenomenon in younger adults (see Symons & Johnson, 1997, for a review), yet relatively few studies have investigated its application to older adults experiencing normal memory decline. Studies of the SRE that have been conducted in older adults (as well as the majority of studies in young adults) use trait adjectives to investigate whether words such as *calm, rude, or friendly* are remembered better if they are learned in reference to the self (e.g., "Does this word describe me?") compared to semantic (e.g., "Does this word describe a desirable personality trait?") and structural (e.g., "Does this word contain the letter 'e'?") manipulations. These studies demonstrate the effectiveness of the SRE in aging on tests of recall (Mueller, Wonderlich, & Dugan, 1986) and recognition (Genon et al., 2014; Glisky & Marquine, 2009; Gutchess, Kensinger, Yoon, & Schacter, 2007; see also Dulas, Newsome, & Duarte, 2011; Hamami, Serbun, & Gutchess, 2011; Leshikar & Duarte, 2014; Trelle, Henson, & Simons, 2015, for findings of an SRE in aging for object recognition, source memory, and free recall and recognition of concrete nouns).

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Though common trait adjective paradigms capitalise on semantic self-referencing, a process that appears less vulnerable to memory decline, trait adjective words are unlikely to simulate real-world demands on memory. Narrative material engages different and much richer processes than single items (e.g., trait adjective words), 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 would provide a more ecologically valid approach to investigating the usefulness of the SRE for enhancing memory in healthy aging. Previous work has shown 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). Memory for narrative information is integral to everyday functioning as it characterises 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), and the integration of personal narratives has been thought to influence the overall coherence of self identity (Mar, Peskin, & Fong, 2011) and maintaining a 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; 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 et al., 2006, 2009; Schacter, Gaesser, & Addis, 2013). The SRE may provide a unique way to help 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 either young adults or older adults. An early study by Reeder, McCormick, and Esselman (1987) showed that memory for personality profiles is enhanced when self-referential processing is emphasised 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 emphasised either self-specific, semantic, or structural encoding. Their findings indicated a *self-imagination effect*, where sentences imagined from a personal perspective promote enhanced recognition when compared to those in the other conditions. The current study adds to this limited literature by investigating the SRE for complex narratives in healthy older adults using both tests of recall and recognition, and also by exploring the retrieval experience associated with narrative information learned through self-referential processing.

The retrieval experience associated with processing material in different ways at encoding can be investigated through a remember/know decision at recognition (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, is demonstrated in subsequent research in younger adults (van den Bos, Cunningham, Conway, & Turk, 2010) and healthy older adults (Genon et al., 2014; Leshikar, Dulas, & Duarte, 2014), but not in older adults diagnosed with Alzheimer's disease (Genon et al., 2014). To our knowledge, the SRRE has not been investigated for narrative information. Since narratives are detailed and context-rich stimuli, they may elicit higher rates of recollection than other types of material, such as trait adjectives. Furthermore, findings of an SRRE for narrative material would provide insight into mechanisms underlying the SRE for this type of information. Findings that the SRE promotes recollection would have particular clinical utility, as recollection is known to be especially vulnerable to changes in healthy aging (Bastin & Van der Linden, 2003; Java, 1996; Light et al., 2000; Mäntylä, 1993).

The influence of valence on memory in younger and older adults was also of interest in the current study, as previous research is inconsistent as to whether differences in valence preferences exist between these age groups. For example, Leshikar et al. (2014) investigated the role of valence in the manifestation of the SRRE in younger and older adult groups, and found that recollection is higher for positive versus negative information in both age groups. This is in contrast to previous research showing richer memory for positively valenced information ("positivity bias") specific to older adults (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2005) but is consistent with other studies showing similar valence preferences across the lifespan (Fernandes, Ross, Wiegand, & Schryer, 2008; Grühn, Smith, & Baltes, 2005; Murphy & Isaacowitz, 2008). Furthermore, previous studies specifically investigating the influence of self-referential processing on memory for trait adjectives in healthy aging have measured recognition memory by subtracting identification of incorrect items (false alarms) from correct items (hits), showing 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). Our study aimed to further clarify whether item valence influences memory across the lifespan and whether these effects are similar or different between young and older age groups.

We included additional analyses of false alarm rates to determine whether for narrative information, older adults would be more susceptible to making false alarms than young adults and whether both age groups would be more susceptible to endorsing positively valenced distractor stimuli, as in previous studies of the SRE for trait adjective words (Glisky & Marquine, 2009; Gutchess et al., 2007 Experiment 1).

Both cued recall and recognition tests were included in our study to allow us to delineate whether the utility of self-referential encoding is influenced by type of task employed at retrieval. Recall is shown to be more vulnerable to the effects of aging than recognition (Botwinick & Storandt, 1980; Craik, 1977). Moreover, performance on a cued recall task may be more ecologically valid than recognition, as recognition tasks provide environmental support that is rarely present in real-world situations. Indeed, Grilli and Glisky (2011, 2013) found that imagining words from a personal perspective benefits recall in both individuals with neurological damage and healthy controls (however see Trelle et al., 2015, for contradictory evidence indicating that self-referential processing of concrete nouns does not benefit recall). Furthermore, Murphy and Isaacowitz (2008) indicate that valence and age effects can be related to type of memory test employed (recall vs. recognition).

In two experiments, we investigated the existence of an SRE for narrative information in healthy young and older adults. We hypothesised that results of the novel narrative paradigm would mirror those of the established trait adjective paradigm, showing: (a) enhanced cued recall and recognition memory for information encoded self-referentially, followed by information encoded through semantic processing, and the least benefit for information encoded through structural (baseline) processing; (b) within recognition tests, a higher rate of recollective "remember" responses for stimuli encoded under self-reference conditions compared to semantic and structural conditions; (c) an SRE and SRRE pattern for both young and older adult groups, but higher memory performance overall for younger adults, especially on the cued recall test; and (d) a positivity bias in the older adults if valence proved to influence memory differently in older versus younger adults; however the manifestation of consistent valence preferences across the lifespan was also possible.

Experiment 1

Methods

Participants

Twenty-four younger adults (mean age = 21.0 years, SD = 3.1 years; range = 18–28 years) and 24 older adults (mean age = 70.3 years, SD = 4.4 years; range = 63–79 years) participated in the study. Each group consisted of an equal number of males and females. Older adults had significantly more years of education ($M = 16.7$ years, SD = 3.5 years) than younger adults ($M = 14.6$ years, SD = 2.6 years) at the time of testing, $t(46) = -2.4$, $p = .02$. Younger adults were recruited from York University's Undergraduate Research Participant Pool and from the community, receiving course credit or monetary compensation for their participation. Older adults were recruited from a database of research volunteers at Baycrest and through advertisements. Older adults received monetary compensation for their participation. The telephone interview for cognitive status (Brandt, Spencer, & Folstein, 1988) was administered to older adults at the time of recruitment to ensure that general cognitive status was within the normal range for study eligibility. A brief medical history was also taken over the phone for older adults to rule out the presence of health conditions known to affect cognition (e.g., stroke, diabetes, and traumatic brain injury). At the beginning of the study session, younger and older adults provided detailed medical background information, with exclusionary criteria including a history of neurological or psychiatric illness, significant signs of cardiovascular disease (e.g., heart attack, cardiac arrest, and heart surgery), diabetes, and history of substance abuse. Informed consent was obtained from all participants in accordance with the procedures of Baycrest's and York University's Research Ethics Boards. Each participant was tested in a single, three-hour study session.

Neuropsychological measures

A brief battery of targeted neuropsychological tests was administered to both younger and older adults in order to confirm that cognitive performance was within age and education expectations, and that current mood status (level of self-reported anxiety and depression) was within normal limits. These included measures of verbal learning and memory (Hopkins verbal learning test, Brandt & Benedict, 2001), working memory (digit span, Wechsler, 1997), processing speed (digit-symbol coding, Wechsler, 1997), incidental memory (digit-symbol coding incidental learning), vocabulary (vocabulary, Wechsler, 1999), and overall cognitive functioning (Montreal cognitive assessment [MoCA], Nasreddine et al., 2005; only administered to older adult group). We found that eight of the older adults performed below the originally suggested cut-off score for the MoCA, which is 26/30 (Nasreddine et al., 2005). There is some debate in the literature as to an appropriate cut-off score for the MoCA, with some researchers arguing for a lower cut-off to indicate normal/abnormal cognition (e.g., Luis, Keegan, & Mullan, 2009; Rossetti, Lacritz, Culllum, & Weiner, 2011). Importantly, our eight participants with lower MoCA scores (range 21–25) performed in the expected range for age and education on all other neuropsychological measures administered. Mood status was measured using the Hospital Anxiety and Depression Scale (HADS, Zigmond & Snaith, 1983), and self-reported symptoms of anxiety and depression were found to be in the normal to mild range.

Trait adjective paradigm

A commonly used trait adjective paradigm was administered to ensure that participants exhibited the SRE to aid interpretation of the novel narrative paradigm. In addition we were interested in further exploring the influence of valence on the SRE, as well as on the SRRE for trait adjectives.

Materials

Stimuli included personality trait adjectives rated according to "likeability" (Anderson, 1968). One hundred and twenty words with the highest positive rankings and 120 words with the highest negative rankings were randomly assigned to either the study lists or the distractor list used in the recognition task. Twelve study lists were created, each comprised of 10 words (half positive and half negative). For the recognition test, a list of 120 distractor items was used for 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 modelled after that employed by Fossati et al. (2003, 2004). Four of the 12 study lists were assigned to each of the 3 study conditions, and allocation of list to condition was counterbalanced across participants. Blocked conditions were presented in a pseudo-randomised order, with no two blocks of the same condition appearing sequentially. Presentation of each block began with an instruction screen indicating which of the three decisions (self-reference, semantic, or structural) would be made for the 10 trials of trait adjectives that followed. Each individual trial consisted of a fixation cross presented for 500 ms followed by a trait adjective word presented for 4.5 s, during which time the participant was prompted to make his/her yes/no judgment. This was followed by a 5 s fixation cross. Presentation order of words within blocks was randomised across participants. Practice trials preceded the test trials. Response type (yes or no) was recorded for each judgment. During a 10-min retention interval, digit span and WAIS-III digit-symbol coding and incidental learning 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, 120 studied trait adjectives and 120 distractors were presented in random order, with the same list of distractor items used for all participants. When a participant indicated that a trait adjective was previously studied ("old"), he or she was asked to make an additional remember/know decision with a button press. A "remember" button press indicated that the participant could 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 could not relate any episodic or contextual detail with seeing it previously. The recognition test was self-paced and responses were recorded. Administration of the trait adjective paradigm preceded that of the narrative paradigm for all participants.

Narrative paradigm

Materials

Narratives presented in the study phase were generated and equated according to the number and type of event details using the autobiographical interview scoring method (Levine et al., 2002; see Appendix 1). Each narrative contained only internal details—episodic details that specifically relate to the event described in the story. Narratives were written from the first-person perspective and detailed either a positive or negative experience, including perceptual elements and the thoughts and feelings of the protagonist. In a pilot session, narratives were rated in terms of ease of comprehension, emotional valence, identification with the protagonist, and ease of visualisation (as in Fotopoulou, Conway, Solms, Tyrer, & Kopelman, 2008). Each of the narratives was 3–4 sentences in length (46–53 words), with half of the narratives describing 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 was analysed 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[1]). Narratives were randomly assigned to 6 study lists of 6 narratives each (3 positive and 3 negative per list) and 1 distractor list of 36 narratives (half positive and half negative).

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 commenced with an instruction screen that stated,

> 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 commenced with an instruction screen that stated, "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 commenced with an instruction screen that stated, "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), using a paradigm closely modelled after the trait adjective paradigm. 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 pseudo-randomised order, with no two blocks of the same condition appearing sequentially. Presentation of each block began with an instruction screen that informed the participant of the judgment they would 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 s,[2] 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 s. Presentation order of narratives within a given block was randomised across participants. Practice trials preceded test trials. Reaction time and response type (yes/no) were recorded for each judgment. During a 10-min retention interval, participants were administered the WASI Vocabulary subtest and a subtraction task devised by the investigators. This was followed by a cued recall test 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. Following the cued recall test, a recognition test required participants to distinguish previously studied narratives from distractor narratives (old/new button press). For the recognition test, 36 studied narratives and 36 distractors were presented in random order. Half of the distractors had the same titles as studied narratives but included novel content and half had completely novel titles and content. All of the distractor stories were composed of the same number and type of details (according to Autobiographical Interview scoring) as the studied narratives, and there was an equal number positive and negative distractor narratives (see Appendix 2, *Experiment 1* items, for samples of a studied narrative, distractor narrative with the same title but novel content, and distractor narrative with a completely novel title and novel content). When a participant indicated that a narrative was 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.

Scoring of narrative cued recall test

Narrative cued recall was scored according to a scoring key created for each narrative in order to standardise scoring between raters. An example of the narrative cued recall scoring procedure is presented in Appendix 1. 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 us to compare 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 by Pearson's correlation and raters showed high reliability with a coefficient of 0.98.

Results[3]

Trait adjective recognition

Recognition memory scores were calculated for each condition by subtracting false alarm rate from hit rate (corrected recognition; raw scores presented in Table 1). 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 age groups. A $2 \times 3 \times 2$ (age group × encoding condition × valence) repeated-measures analysis of variance (ANOVA) revealed a main effect of condition, $F(2,92) = 121.04$, $p < .001$, $\eta^2 = 0.73$, and 2×2 follow-up ANOVAs (young/older × self/semantic and young/older × semantic/structural) indicated an SRE, with trait adjectives encoded in the self-reference condition showing enhanced memory over those encoded in the semantic condition, $F(1,46) = 15.53$, $p < .001$, $\eta^2 = 0.25$, and trait adjectives encoded in the semantic condition showing enhanced memory over those encoded in the structural condition, $F(1,46) = 142.92$, $p < .001$, $\eta^2 = 0.78$. The age by condition interaction did not reach significance $F(2,92) = 0.187$, $p = .83$, $\eta^2 = 0.004$.

There was no significant main effect of valence, $F(1,46) = 1.83$, $p = .183$, $\eta^2 = 0.04$. However, results indicated an age by valence interaction, $F(1,46) = 9.02$, $p = .004$, $\eta^2 = 0.16$, and further comparisons revealed that older adults showed higher levels of recognition for positive trait adjectives across conditions, $t(23) = 3.5$, $p = .002$, whereas

Table 1. Trait adjective and narrative recognition hits, false alarms, and corrected recognition, by age and valence

	Hits				Corrected recognition (hits–false alarms)		
	Self-reference	Semantic	Structural	False alarms	Self-reference	Semantic	Structural
Experiment 1							
Trait adjective							
Young							
Positive	.84 (.11)	.80 (.13)	.53 (.21)	.33 (.15)	.51 (.15)	.47 (.17)	.19 (.15)
Negative	.81 (.12)	.70 (.16)	.47 (.19)	.24 (.14)	.56 (.13)	.46 (.20)	.22 (.16)
Older							
Positive	.76 (.15)	.66 (.17)	.44 (.21)	.31 (.18)	.45 (.17)	.35 (.11)	.13 (.12)
Negative	.54 (.20)	.52 (.18)	.25 (.16)	.18 (.15)	.35 (.17)	.33 (.15)	.07 (.12)
Narrative							
Young							
Positive	.97 (.08)	.97 (.08)	.78 (.20)	.04 (.07)	.94 (.10)	.94 (.09)	.74 (.21)
Negative	.98 (.06)	.94 (.11)	.87 (.18)	.02 (.03)	.96 (.08)	.92 (.10)	.85 (.18)
Older							
Positive	.96 (.16)	.93 (.19)	.45 (.31)	.04 (.04)	.92 (.12)	.89 (.15)	.41 (.26)
Negative	.95 (.13)	.93 (.18)	.46 (.32)	.03 (.05)	.92 (.08)	.91 (.12)	.44 (.27)
Experiment 2							
Narrative							
Older							
Positive	.87 (.15)	.80 (.15)	.47 (.29)	.10 (.12)	.77 (.20)	.71 (.16)	.37 (.26)
Negative	.88 (.13)	.82 (.17)	.47 (.24)	.08 (.08)	.81 (.13)	.75 (.20)	.40 (.26)

Note: Values represent means (SD).

younger adults did not exhibit a difference in recognition according to valence $t(23) = -1.06$, $p = .3$. A main effect of age was revealed, with younger adults showing higher recognition accuracy than older adults across all conditions, $F(1,46) = 18.02$, $p < .001$, $\eta^2 = 0.28$.

Contrary to previous studies (Glisky & Marquine, 2009; Gutchess et al., 2007), there was no significant difference between the overall false alarm rates of younger and older groups (i.e., older adults did not make more false alarms), $F(1,46) = 0.98$, $p = .33$, $\eta^2 = 0.02$. However, valence was found to influence the false alarm rate across age group, with both younger and older adults showing more false alarms for positively valenced trait adjectives, $F(1,46) = 42.15$, $p < .001$, $\eta^2 = 0.48$. No significant interaction was indicated for false alarm valence by age, $F(1,46) = 1.17$, $p = .29$, $\eta^2 = 0.03$.

We analysed whether trait adjectives that were initially self-endorsed as traits reflecting the participant in the self-reference condition were more likely to be recognised than those that were unendorsed. A 2 × 2 mixed ANOVA was used, with age group as the between-subjects factor and proportion of endorsed or unendorsed traits that were later recognised as the within-subjects factor. This analysis indeed revealed that trait adjectives that were endorsed as self-descriptive in the self-reference condition were remembered better at recognition than unendorsed trait adjectives, $F(1,45) = 15.04$, $p < .001$, $\eta^2 = 0.25$, and these results pertained to both younger and older age groups, as no interaction was revealed, $F(1,45) = 15.04$, $p = .19$, $\eta^2 = 0.04$.

Trait adjective recollection and familiarity

Recollection and familiarity were measured during the trait adjective recognition task by having participants make a remember (estimate of recollection)/know (estimate of familiarity) button press for recognised words. Recollection and familiarity estimates were calculated according to the independence remember know method (Jacoby, Yonelinas, & Jennings, 1997; Yonelinas & Jacoby, 1995), which holds that the two are independent processes and therefore familiarity should not simply reflect an absence of recollection (Ozubko & Yonelinas, 2012). Following this method, estimates of recollection were calculated for each condition as (proportion remember hits—proportion remember false alarms). Familiarity estimates were calculated for each condition as (proportion of know hits/1 −proportion of remember hits)−(proportion know false alarms/1−proportion remember false alarms). Mention of “estimates of recollection” and “estimates of familiarity” will reflect these calculations throughout the paper. Recollection and familiarity results are presented in Tables 2 and 3.

Estimates of recollection and familiarity were analysed by separate 2 × 3 (age group × encoding condition) repeated-measures ANOVAs.[4] An analysis of estimates of recollection indicated a main effect of condition, $F(2,90) = 180.53$, $p < .001$, $\eta^2 = 0.80$, and follow-up 2 × 2 ANOVAs (young/older × self/semantic and young/older × semantic/structural) indicated an SRRE, with trait adjectives encoded in the self-reference condition showing higher estimates of recollection than those in the semantic condition, $F(1,45) = 30.505$, $p < .001$, $\eta^2 = 0.40$, which, in turn, received more remember responses than the structural condition, $F(1,45) = 96.36$, $p < .001$, $\eta^2 = 0.68$. The age by condition interaction was non-significant for estimates of recollection, $F(2,90) = 0.91$, $p = .41$, $\eta^2 = 0.02$, as was the main effect of valence, $F(1,45) = 0.18$, $p = .68$, $\eta^2 = 0.004$, and the age by valence interaction, $F(1,45) = 3.1$, $p = .09$, $\eta^2 = 0.07$. Although older groups showed the SRRE, their younger counterparts had significantly higher estimates of recollection across conditions, $F(1,45) = 3.9$, $p = .05$, $\eta^2 = 0.08$.

Table 2. Proportion of stimuli receiving remember or know responses, by age, encoding condition, and valence

	Self-reference				Semantic				Structural				New			
	Remember		Know		Remember		Know		Remember		Know		Remember		Know	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Experiment 1																
Trait adjective																
Young	.55 (.26)	.58 (.19)	.28 (.17)	.23 (.09)	.48 (.28)	.41 (.23)	.33 (.16)	.28 (.16)	.25 (.21)	.18 (.19)	.27 (.16)	.28 (.13)	.12 (.11)	.04 (.06)	.24 (.13)	.20 (.10)
Older	.50 (.32)	.32 (.20)	.25 (.24)	.23 (.20)	.38 (.30)	.31 (.24)	.27 (.20)	.22 (.13)	.23 (.26)	.10 (.15)	.19 (.19)	.14 (.14)	.13 (.14)	.06 (.09)	.16 (.14)	.12 (.12)
Narrative																
Young	.88 (.20)	.94 (.08)	.05 (.10)	.04 (.07)	.85 (.17)	.83 (.18)	.13 (.16)	.12 (.15)	.51 (.32)	.61 (.27)	.24 (.26)	.22 (.23)	.01 (.03)	.00 (.02)	.02 (.04)	.01 (.03)
Older	.78 (.26)	.82 (.28)	.18 (.27)	.13 (.27)	.72 (.30)	.78 (.24)	.22 (.28)	.16 (.22)	.30 (.29)	.28 (.22)	.15 (.18)	.18 (.19)	.02 (.04)	.01 (.03)	.02 (.04)	.01 (.03)
Experiment 2																
Narrative																
Older	.74 (.25)	.77 (.21)	.14 (.18)	.13 (.19)	.71 (.22)	.68 (.25)	.10 (.12)	.18 (.26)	.28 (.27)	.33 (.24)	.19 (.23)	.12 (.13)	.05 (.08)	.02 (.03)	.06 (.07)	.07 (.08)

Note: Values represent means (SD).

The analysis of estimates of familiarity also revealed a main effect of condition, $F(2,90) = 28.69$, $p < .001$, $\eta^2 = 0.39$, and follow-up 2×2 ANOVAs (young/older × self/semantic, young/older × semantic/structural, young/older × self/structural) revealed no significant difference between self-reference ($M = 0.38$) and semantic conditions ($M = 0.39$), $F(1,45) = 0.15$, $p = .7$, $\eta^2 = 0.003$, but significantly higher estimates of familiarity in these conditions when compared to the structural condition ($M = 0.13$; self-reference vs. structural, $F(1,45) = 35.87$, $p < .001$, $\eta^2 = 0.44$; semantic vs. structural, $F(1,45) = 63.77$, $p < .001$, $\eta^2 = 0.59$). A significant age by condition interaction was not revealed, $F(2,90) = 0.60$, $p = .55$, $\eta^2 = 0.01$. The main effect of valence for estimates of familiarity showed a trend towards significance, $F(1,45) = 3.58$, $p = .07$, $\eta^2 = 0.07$, with positively valenced words more strongly associated with estimates of familiarity than negatively valenced words. No age by valence interaction was revealed, $F(1,45) = 0.03$, $p = .86$ $\eta^2 = 0.001$. There was no main effect of age revealed for estimates of familiarity, $F(1,45) = 2.68$, $p = .11$ $\eta^2 = 0.06$.

Narrative cued recall

Narratives generated by participants were segmented into details, and the number of details recalled from each narrative was summed according to presentation condition and valence. Results are shown in Figure 1. A $2 \times 3 \times 2$ mixed repeated-measures ANOVA (age group × encoding condition × valence) indicated a significant effect of condition, $F(2,92) = 153.34$, $p < .001$, $\eta^2 = 0.77$, and subsequent 2×2 follow-up ANOVAs (young/older × self/semantic and young/older × semantic/structural) revealed an SRE, with more details recalled in the self-reference condition than in the semantic condition, $F(1,46) = 6.86$, $p = .01$, $\eta^2 = 0.13$, and the fewest number of details recalled in the structural condition, $F(1,46) = 171.84$, $p < .001$, $\eta^2 = 0.79$. There was no evidence of an age by condition interaction, $F(2,92) = 0.04$, $p = .96$, $\eta^2 = 0.001$. A main effect of valence was apparent, $F(1,46) = 42.71$, $p < .001$, $\eta^2 = 0.48$, revealing better recall for negatively valenced narrative details than positively valenced details across both younger and older adult groups. An age by valence interaction did not reach statistical significance, $F(1,46) = 0.30$, $p = .59$, $\eta^2 = 0.01$. A main effect of age was revealed, $F(1,46) = 44.3$, $p < .001$, $\eta^2 = 0.49$, indicating that younger adults recalled more details than older adults across study conditions.

Narrative recognition

Scores for the narrative recognition task were corrected (hit rate minus false alarm rate) and analysed in a mixed $2 \times 3 \times 2$ (age group × encoding condition × valence) repeated-measures ANOVA. Raw scores are shown in Table 1. Analyses revealed a main effect of condition, $F(2,92) = 109.94$, $p < .001$, $\eta^2 = 0.71$. Subsequent 2×2 follow-up ANOVAs (young/older × self/semantic and young/older × semantic/structural) indicated no significant difference in recognition of narratives encoded in self-reference and semantic conditions, $F(1,46) = 2.49$, $p = .12$,

Table 3. Estimates of recollection (hits–false alarms) for trait adjective and narrative paradigms, by age and valence

	Young		Older	
	Positive	Negative	Positive	Negative
Experiment 1				
Trait adjective				
Self-reference	.44 (.14)	.53 (.13)	.36 (.18)	.25 (.11)
Semantic	.36 (.18)	.37 (.17)	.24 (.16)	.24 (.16)
Structural	.13 (.10)	.14 (.13)	.09 (.11)	.05 (.06)
Narrative				
Self-reference	.87 (.19)	.93 (.08)	.76 (.26)	.81 (.29)
Semantic	.84 (.16)	.83 (.18)	.70 (.30)	.76 (.24)
Structural	.50 (.32)	.61 (.27)	.28 (.30)	.27 (.23)
Experiment 2				
Narrative				
Self-reference			.69 (.24)	.76 (.20)
Semantic			.66 (.19)	.66 (.25)
Structural			.24 (.26)	.32 (.23)

Note: Values represent means (SD).

$\eta^2 = 0.05$, but significantly lower recognition for narratives encoded in the structural condition, $F(1,46) = 113.72$, $p < .001$, $\eta^2 = 0.71$. Ceiling effects were apparent for narratives encoded in the self-reference and semantic conditions for both younger and older groups. There was no main effect of valence for the narrative recognition task, $F(1,46) = 2.86$, $p = .1$, $\eta^2 = 0.06$, nor was there an age by valence interaction, $F(1,46) = 0.46$, $p = .5$, $\eta^2 = 0.01$. A main effect of age was revealed, with younger adults showing better overall recognition than older adults, $F(1,46) = 29.22$, $p < .001$, $\eta^2 = 0.39$. There was a significant age by condition interaction, $F(2,92) = 32.9$, $p < .001$, $\eta^2 = 0.42$, but follow-up 2 × 2 ANOVAs (young/older × self/semantic and young/older × semantic/structural) indicated that there was no significant difference in recognition performance between younger and older adults when comparing narratives encoded in the self-reference and semantic conditions, $F(1,46) = 0.01$, $p = .91$, $\eta^2 = 0.00$. Nevertheless,

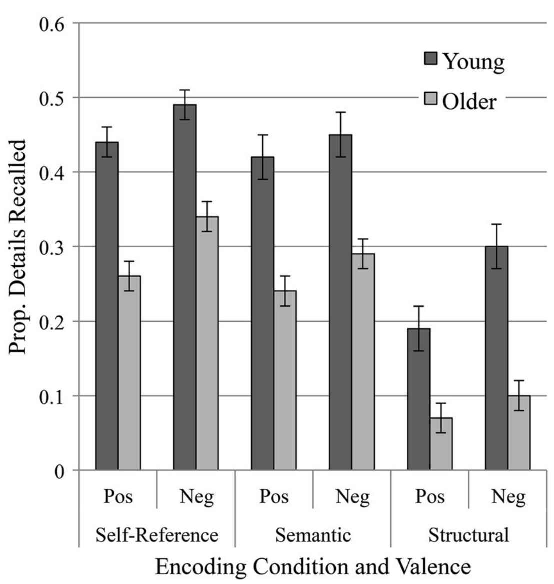

Figure 1. Proportion of narrative details recalled as a function of age group, encoding condition, and valence. Error bars represent standard error. Note: Pos, positive; Neg, negative.

younger adults exhibited significantly higher recognition for narratives encoded in the structural condition than their older counterparts, $F(1,46) = 36.63$, $p < .001$, $\eta^2 = 0.44$.

A 2 × 2 (age group × valence) repeated-measures ANOVA of false alarms (distractor narratives incorrectly identified as previously studied) showed a main effect of valence, $F(1,46) = 4.1$, $p = .05$, $\eta^2 = 0.08$, with significantly more false alarms for positively than negatively valenced narratives across age group. A main effect of age was not exhibited, indicating no significant difference in number of false alarms made by younger and older adult groups, $F(1,46) = 0.26$, $p = .62$, $\eta^2 = 0.01$. Furthermore, no age by valence interaction was revealed for false alarms made during the narrative recognition task, $F(1,46) = 0.06$, $p = .81$, $\eta^2 = 0.08$.

Similar to the trait adjective paradigm, we analysed whether narratives in the self-reference condition that were initially endorsed as eliciting an event that could be easily imagined lead to a benefit in memory at recognition. A 2 × 2 mixed ANOVA (age group × proportion endorsed or unendorsed and later recognised) revealed that narratives endorsed as easily imaginable by the participant were more accurately recognised than narratives that were unendorsed, $F(1,45) = 23.86$, $p < .001$, $\eta^2 = 0.35$. This pattern was consistent across age groups, as there was no significant age by endorsement interaction revealed, $F(1,45) = 1.47$, $p = .23$, $\eta^2 = 0.03$.

Narrative recollection and familiarity

As in the trait adjective paradigm, we measured whether the SRRE was present for narrative information through an analysis of estimates of recollection (results presented in Tables 2 and 3). Estimates of recollection were again calculated by corrected recognition (hit rate minus false alarm rate). A 2 × 3 (age group × encoding condition) mixed ANOVA revealed a main effect of condition, $F(2,90) = 93.14$, $p < .001$, $\eta^2 = 0.67$, and results of follow-up 2 × 2 ANOVAs (young/older × self/semantic and young/older × semantic/structural) were consistent with an SRRE showing higher estimates of recollection for narratives encoded in the self-reference versus semantic condition, $F(1,45) = 7.59$, $p = .008$, $\eta^2 = 0.14$, and higher estimates of recollection for narratives encoded in the semantic condition versus the structural condition, $F(1,45) = 99.25$, $p < .001$, $\eta^2 = 0.69$. A main effect of age was indicated, with younger adults showing higher estimates of recollection than their older adult counterparts across study conditions, $F(1,45) = 10.89$, $p = .002$, $\eta^2 = 0.20$. However, a significant age by condition interaction was revealed, $F(2,90) = 4.0$, $p = .02$, $\eta^2 = 0.08$, and subsequent 2 × 2 ANOVAs indicated no significant difference in estimates of recollection between young and older groups when comparing narratives encoded through self-reference and semantic processing, $F(1,45) = 0.18$, $p = .67$, $\eta^2 = 0.004$, but younger adults showed higher rates of recollection for narratives encoded through structural processing than older adults, $F(1,45) = 5.6$, $p = .02$, $\eta^2 = 0.11$. A main effect of valence was revealed, $F(1,45) = 6.79$, $p = .01$, $\eta^2 = 0.13$, indicating that in both younger and older adult groups, negatively valenced narratives were associated with higher estimates of recollection than positively valenced narratives. A significant age by valence interaction was not found, $F(1,45) = 0.40$, $p = .53$, $\eta^2 = 0.009$.

Ceiling effects for estimates of recollection indicated that many cases had to be excluded in the analysis of estimates of familiarity, as high estimates of recollection give little (or no) opportunity for estimates of familiarity, rendering them unreliable. All of the participants except two younger and three older adults showed at least one condition in which no familiarity responses (know responses) were endorsed. For this reason, we were unable to analyse estimates of familiarity for narratives.

Discussion

Experiment 1 replicated the SRE found for trait adjectives in healthy young and older adults (Genon et al., 2014; Glisky & Marquine, 2009; Gutchess et al., 2007), as well as higher estimates of recollection associated with self-referenced trait adjectives in both age groups (Conway et al., 2001; Conway & Dewhurst, 1995; Genon et al., 2014; Leshikar et al., 2014). A positivity bias was found for older adults in the recognition of trait adjectives, whereas no valence preferences were found for young adults. Though both groups showed an SRE, overall recognition accuracy was higher for young adults than for their older counterparts.

Results of the novel narrative paradigm indicated that self-referential processing enhanced recall of narrative information in both young and older age groups, and that memory was better for negatively valenced details of stories across age groups. Though both groups benefitted from the SRE manipulation, overall recall was higher for young versus older adults. Results of the narrative recognition test revealed better memory for the self-reference and semantic conditions compared to the structural conditions in both young and older adults, but neither differences between the two deep encoding tasks nor valence were detected, possibly due to ceiling effects. Higher overall estimates of recollection were revealed for younger adults compared to older adults, but an SRRE was present in both age groups, such that higher estimates of recollection were associated with narratives encoded in the self-reference condition. Nevertheless, a second experiment was conducted to better determine whether there was a benefit to encoding information self-referentially over semantic encoding. To bring recognition accuracy scores off of the ceiling we increased the level of difficulty of the narrative recognition task and tested a new sample of healthy older adults on the narrative paradigm.

Experiment 2

Methods

Participants

A separate group of 17 healthy older adults (mean age = 68.4 years, SD = 4.9 years; age range 62–79 years; 5 males, 12 females) participated in Experiment 2. They had a mean education of 15.5 years (SD = 3.1 years). Participants were recruited from the same sources as in Experiment 1 and went through the same cognitive and medical screening procedures in order to meet eligibility requirements. Informed consent was obtained from all participants in accordance with Research Ethics Board procedures at Baycrest and York University. The study session lasted approximately two hours for each participant.

Neuropsychological measures

Participants were administered the same standard neuropsychological measures as in Experiment 1. Although they performed normally on a range of standard neuropsychological measures, 3 participants achieved a score on the MoCA that was 1-point lower than the recommended cut-off (score of 25 with 26 as the cut-off). Given that the appropriate MoCA cut-off score is currently debated (as mentioned above) and that these participants performed in the normal range on standard tests of neurocognitive ability and only one point below the recommended cut-off on the MoCA, it was decided that they would be included in Experiment 2. This decision was further supported by the fact that omitting data from these three participants did not change the pattern of results.

Materials and procedure

The narratives presented and study phase were identical to those used in Experiment 1. A critical difference between the two experiments was that less information was provided to participants during the recognition test in order to increase the difficulty. Specifically, instead of presenting entire narratives with accompanying titles to participants at recognition, the test was adapted so that participants were provided with only a short phrase ($M = 9.8$ words, SD = 3.2) that captured the main idea of the original content of each story without revealing the story titles (see Appendix 2 for an example). Phrases from studied narratives were randomly intermixed with those from narratives that were not previously seen (distractor items). Identical to Experiment 1, participants made an old/new judgment as to whether the material presented was from a story he/she had previously read in the experiment. If they indicated that they had read a narrative, they were then asked to make a remember/know judgment about their memory for that specific narrative. As in Experiment 1, the recognition portion was self-paced, and responses were recorded with E-Prime software.

Results

Our adaptations to the narrative recognition test successfully brought the scores off of the ceiling. As in Experiment 1, narrative recognition accuracy scores were corrected (hit rate minus false alarm rate) and analysed in a 2 × 3 (valence × encoding condition) repeated-measures ANOVA (see Figure 2 for a comparison of results between the two experiments). Analyses revealed a main effect of condition, $F(2,32) = 51.49$, $p < .001, \eta^2 = 0.76$, and subsequent comparisons indicated an SRE, with narratives encoded in the self-reference condition showing better recognition accuracy than those in the semantic condition, $t(16) = 2.52$, $p = .02$, and higher recognition accuracy for narratives encoded in the semantic condition than those in the structural condition, $t(16) = 7.09$, $p < .001$. No significant main effect of valence was found, $F(1,16) = 0.58$, $p = .46$, $\eta^2 = 0.04$. An analysis of false alarms indicated no significant difference according to valence, $t(16) = 1.2$, $p = .23$.

We additionally investigated recollection and familiarity for the revised narrative recognition paradigm (see Tables 2 and 3 for results). An analysis of estimates of recollection indicated a main effect of condition, $F(2,32) = 35.6$, $p < .001$, $\eta^2 = 0.69$. Although the pattern of results indicated numerically higher estimates of recollection for the self-reference condition ($M = 0.72$), followed by the semantic condition ($M = 0.66$), and lastly the structural condition ($M = 0.28$), the self-reference and semantic conditions were not found to be significantly different, $t(16) = 1.24$, $p = .23$, but were significantly higher than the structural condition, $t(16) = 6.58$, $p < .001$. This is in contrast to Experiment 1, in which there was a clear SRRE for narrative recognition. No significant main effect of valence was revealed, $F(1,16) = 2.1$, $p = .17$, $\eta^2 = 0.12$.

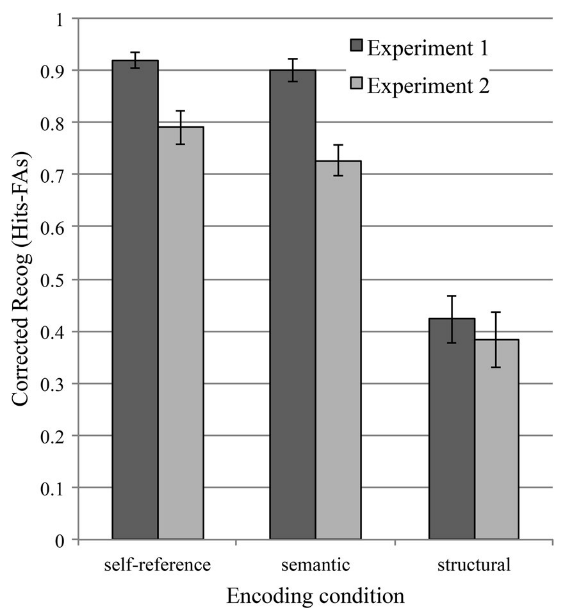

Figure 2. Comparison of older adult narrative recognition scores from Experiments 1 and 2, as a function of encoding condition. Error bars represent standard error.

Estimates of recollection were only slightly lower than in Experiment 1, and once again indicated that many cases had to be excluded in the analysis of estimates of familiarity. Fifteen out of 17 participants showed at least one condition in which no familiarity responses (know responses) were endorsed. For this reason, we were unable to analyse estimates of familiarity for the revised narrative recognition paradigm.

Discussion

Through the employment of a more difficult narrative recognition task, Experiment 2 successfully removed ceiling effects, revealing an SRE for recognition of narrative information in older adults. No effects of valence were revealed. Although the direction of results was consistent with an SRRE, there was no statistical difference found between self-reference and semantic encoding conditions in terms of estimates of recollection. Estimates of recollection in both of these conditions were significantly higher than those in the structural condition.

General discussion

Our study investigated whether memory for narrative information, which is known to decline in healthy aging, benefits from the SRE in both young and older adults, similar to the mnemonic benefits for trait adjectives that have been documented in the literature. Experiment 1 indicated that self-referential encoding benefits not only memory for trait adjectives but also memory for narrative material, by promoting recall of specific story details. Experiment 2 revealed an SRE for narrative recognition when ceiling effects were removed. The following is a detailed discussion of these findings, with a focus on the SRE for narrative information, retrieval experience associated with narrative recognition, and the effects of valence on memory for narratives.

Narrative cued recall

To our knowledge, our study is the first to measure the SRE for narrative material in healthy young versus older adults. A cued recall test for the details of studied narratives showed an SRE across age groups, favouring details of narratives encoded in the self-reference condition, followed by the semantic condition and the structural condition last. This task mirrors real-world scenarios in which one must retrieve details of narrative events with only subtle cues, as opposed to the high level of support offered on tests of recognition. The SRE found for narrative details is supported by other work showing that self-referential processing enhances memory for detailed representations, specifically perceptual details, in young and older adults (Hamami et al., 2011; Leshikar & Duarte, 2014; Serbun, Shih, & Gutchess, 2011). Although older adults showed an SRE on the cued recall test, our finding of higher levels of overall recall for younger versus older adults is consistent with the literature (e.g., Craik & McDowd, 1987). The finding that older adults benefit from this manipulation at all is particularly significant given that both general recall and memory for narrative information have been shown to decline in healthy aging.

Narrative recognition

Narrative recognition was studied in both Experiments 1 and 2. Since Experiment 1 showed ceiling effects for narratives encoded through self-reference and semantic conditions, it was impossible to determine whether recognition memory was indeed similar for these two conditions or whether a true SRE was masked by the ceiling effects. Experiment 2 allowed us to answer this question in healthy older adults, and the results revealed an SRE. The finding of an SRE for narrative information on a recognition test is consistent with the study by Grilli and Glisky (2010), which showed that imagining events from a personal perspective ("self-imagining") enhances memory for sentences in memory-impaired and healthy individuals. Our results add to these findings by showing that self-referencing improves memory for complex narratives, and the effects can be seen in both young and older adults. Ceiling effects in Experiment 1 also impacted our ability to determine whether age effects were present, given that there was no difference in performance between young and older adults for the self-reference and semantic conditions. However, the finding that older adults performed worse on the structural condition than younger adults but nevertheless benefited from deep encoding (whether self-reference or semantic) to show ceiling effects similar to those seen in younger adults emphasises the benefit from deep encoding of narrative information in older adults. Because we tested only older adults in Experiment 2, we are unable to draw conclusions about age effects. However, based on the results of Experiment 1, we would predict younger adults to also show an SRE on our more difficult narrative recognition test.

The recognition task for studied narrative material indicated memory for narratives that was more accurate than recognition of single words (trait adjectives), so much so that there were ceiling effects, with few false alarms made for narratives encoded in either the self-reference or semantic conditions (Experiment 1). It is likely that the rich context of narratives versus single words was associated with the high recognition accuracy exhibited across age 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, Kennedy, Park, Frattali, & Braun, 2005).

Recollection and familiarity

Previous studies have found that retrieval experience is influenced by aging, and that older adults show a decline in recollection while familiarity is less affected (e.g., Bastin & Van der Linden, 2003; Java, 1996; Light et al., 2000; Mäntylä, 1993). Recent research suggests that self-referential processing boosts recollection in older adults on trait adjective paradigms (Genon et al., 2014; Leshikar et al., 2014). Findings from these studies are consistent with the results of Experiment 1, where both young and older adults showed higher estimates of recollection for trait adjectives encoded through self-referential processing than semantic and structural processing. We were curious to know whether an SRRE would likewise be evident for narrative material, particularly in older adults. The narrative recognition test administered in Experiment 1 also showed an SRRE, with narratives encoded in the self-reference condition associated with higher estimates of recollection for both young and older groups despite ceiling effects for overall recognition in the self-reference and semantic conditions. In Experiment 2, though estimates of recollection were numerically higher than in the structural condition, they were not significantly different between the self-reference and semantic conditions. It is surprising that the easier narrative recognition task that provided rich contextual detail at retrieval revealed a significant difference in estimates of recollection between the self-reference and semantic condition, whereas the more difficult narrative recognition test did not. Failure to see a clear SRRE may be due to the small sample size in Experiment 2 or it may be the case that deep encoding processes (whether self-reference or semantic) rely to a similar extent on recollection in memory for narrative information when the recognition task is more difficult. It is possible that an SRRE would have been present in a younger adult sample in Experiment 2, but we were specifically interested in exploring whether there was an effect in older adults, as it is this population who suffers from decreased recollection. Nevertheless, it seems that recollection plays an important role in the enhancement of memory for self-related information and future studies are needed to determine the status of an SRRE in narrative recognition.[5]

Influence of valence

Findings from the present study are largely inconsistent with the idea of a positivity bias for memory selective to older adults (Carstensen & Mikels, 2005; Mather & Carstensen, 2005), and instead favour the view that valence preferences are relatively stable across the lifespan (Fernandes et al., 2008; Grühn et al., 2005; Murphy & Isaacowitz, 2008). The trait adjective recognition task (Experiment 1) provided the only indication of a positivity bias selective to older adults; younger adults showed no influence of valence on memory for trait adjectives. This was in contrast to previous studies of the SRE in healthy aging, with Glisky and Marquine (2009) finding enhanced memory for negative trait adjectives in younger adults and no valence differences in older adults and Gutchess et al. (2007), Experiment 2, finding enhanced memory for negative trait adjectives across age groups. However, in terms of false alarms, findings from the current study are in line with those of Glisky and Marquine (2009) and Gutchess et al. (2007), showing that both younger and older adult groups exhibited a higher proportion of false alarms for positive versus negative trait adjectives. Glisky and Marquine (2009) attributed these findings to separate evidence that positive information is remembered in a more gist-like, general fashion (see Kensinger et al., 2007), making it more difficult to distinguish between studied and distractor items. In the current study, valence was not shown to impact estimates of recollection for trait adjectives, which is in contrast to findings from a recent study by Leshikar et al. (2014) showing enhanced recollection for positive trait adjectives across age groups.

The narrative cued recall test (Experiment 1) revealed enhanced memory for details of negatively valenced narratives in both age groups. This finding 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 et al., 2007; Kensinger, 2009), 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 likely that enhanced memory for negative event details in general is associated with the adaptive and evolutionary value of learning about potentially traumatic and unpleasant situations. No difference in valence preference was evident between age groups, consistent with a meta-analysis by Murphy and Isaacowitz (2008). This suggests that age differences in valence preferences might depend on the methods used to measure memory performance, with recognition tasks more likely to elicit age differences than recall tasks (Murphy & Isaacowitz, 2008).

No influence of valence was apparent for either age group in the narrative recognition task of Experiment 1 or for the older adults tested in Experiment 2, the latter indicating that any lack of effect cannot be explained by ceiling effects, at least in the older adults. Valence effects were found on tests of trait adjective recognition and narrative cued recall. This suggests that valence effects may depend on the level of retrieval support and cognitive resources required, as narrative recognition, which includes more richly detailed stimuli and greater overall structure, may be viewed as less cognitively demanding than the other two tasks.

The SRRE for narrative information found in Experiment 1 revealed that negatively valenced stories are more highly associated with recollection than positively valenced narratives across age groups. This finding is in line with research associating recollective (episodic) experience with recall performance (Yonelinas, 2002), as both narrative cued recall performance and estimates of recollection for the recognition of narrative information in Experiment 1 were higher for negative than positive material across age groups. This finding is also consistent with research showing that detailed memory for negative information is associated with recollection, whereas gist-like memory for positive information is associated with familiarity (Mickley & Kensinger, 2008). However, it must be noted that Experiment 2 did not show an effect of valence on estimates of recollection.

In considering what the results of the present study tell us about the mechanism of the SRE for narrative information, Experiment 1 seems to support the idea that the SRE promotes memory by facilitating retrieval of episodic detail via recollection (Leshikar et al., 2014). Although Experiment 2 showed a pattern consistent with an SRRE, this did not translate to statistically significant estimates of recollection between the self-reference and semantic conditions. This may be taken to suggest that with highly contextualised and richly detailed stimuli such as narratives, the SRE boosts recollection for deep encoding processes, whether influenced by self-reference or semantic manipulations. This would mean that it is another mechanism that underlies the additional benefit seen for overall recognition of self-referenced narratives compared to narratives encoded through semantic processing. It may also be the case that a combination of self-relevant processing and imagining, as emphasised in our narrative self-reference condition, results in unique processes that boost memory. This is supported by findings that a combination of self-referential processing and imagination boost memory performance above that of traditional self-reference manipulations that do not incorporate imagining the self (Grilli & Glisky, 2013).

Conclusion

The present study provides evidence that the SRE can be extended to narrative information in young and older adults. This was revealed on tests of cued recall (Experiment 1) and recognition (Experiment 2; only older adults tested). Since memory for narrative information has real-world importance for socialising and connecting with others as well as maintaining our own autobiographical narratives, the benefits of self-referential processing of narrative information suggests an ecologically valid application of the SRE. This is important, as memory for narrative information is particularly vulnerable to healthy aging (Byrd, 1985; Hultsch & Dixon, 1984; Olofsson & Backman, 1993; Zelinski et al., 1984). While we have evidence to show that the SRE additionally boosts estimates of recollection for narrative information in young and older adults (Experiment 1), it may also be the case that enhanced recollection is similarly achieved by other forms of deep encoding, such as semantic processing (Experiment 2). This is an area that requires further research. In sum, our study has demonstrated that the SRE can serve as an effective compensatory mechanism for boosting memory for narrative information across the lifespan, and represents a particularly promising area for future intervention research with individuals experiencing age-related memory decline.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Notes

1. 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.
2. The duration for which narratives were presented was determined by pilot testing. Additionally, all participants completed a post-experiment questionnaire that asked whether they felt they had sufficient time to read the narratives on the screen and all answers were affirmative.
3. As mentioned above, the older adults in the participant sample had significantly more years of education than the younger adults, and a number of older adult participants performed worse than the recommended cut-off score on the MoCA. However, re-analysis of the data to control for education and without data from individuals scoring below the MoCA cut-off did not change the pattern of results. Thus, the results presented are uncorrected for education and include data from all older adults tested in Experiment 1.
4. Technical issues precluded us from accessing the remember/know data from one of the older adults. The participant's data were thus excluded from the present analysis as well as the corresponding analysis for the narrative recognition test.
5. Although examined for completeness, familiarity was not the focus of this study, and the high estimates of recollection, particularly in the narrative paradigms, made it difficult to estimate familiarity accurately.

References

Addis, D. R., Musicaro, R., Pan, L., & Schacter, D. L. (2010). Episodic simulation of past and future events in older adults: Evidence from an experimental recombination task. *Psychology and Aging*, *25*, 369–376. doi:10.1037/a0017280

Addis, D. R., Wong, A., & Schacter, D. L. (2008). Age-related changes in the episodic simulation of future events. *Psychological Science*, *19*, 33–41. doi:10.1111/j.1467-9280.2008.02043.x

Anderson, N. (1968). Likableness ratings of 555 personality-trait words. *Journal of Personality and Social Psychology*, *9*, 272–279. doi:10.1037/h0025907

Bastin, C., & Van der Linden, M. (2003). The contribution of recollection and familiarity to recognition memory: A study of the effects of test format and aging. *Neuropsychology*, *17*, 14–24. doi:10.1037/0894-4105.17.1.14

Bluck, S., & Habermas, T. (2000). The life story schema. *Motivation and Emotion*, *24*, 121–147. doi:10.1023/A:1005615331901

Bohn, A., & Berntsen, D. (2007). Pleasantness bias in flashbulb memories: Positive and negative flashbulb memories of the fall of the Berlin Wall among East and West Germans. *Memory & Cognition*, *35*, 565–577. doi:10.3758/BF03193295

Botwinick, J., & Storandt, M. (1980). Recall and recognition of old information in relation to age and sex. *Journal of Gerontology*, *35*, 70–76. doi:10.1093/geronj/35.1.70

van den Bos, M., Cunningham, S. J., Conway, M. A., & Turk, D. J. (2010). Mine to remember: The impact of ownership on recollective experience. *The Quarterly Journal of Experimental Psychology*, *63*, 1065–1071. doi:10.1080/17470211003770938

Brandt, J., & Benedict, R. H. (2001). *Hopkins verbal learning test, revised: Professional manual*. Odessa, FL: Psychological Assessment Resources.

Brandt, J., Spencer, M., & Folstein, M. (1988). The telephone interview for cognitive status. *Neuropsychiatry, Neuropsychology, & Behavioral Neurology*, *1*, 111–117.

Byrd, M. (1985). Age differences in the ability to recall and summarize textual information. *Experimental Aging Research*, *11*, 87–91. doi:10.1080/03610738508259285

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science*, *14*, 117–121. doi:10.1111/j.0963-7214.2005.00348.x

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Ageing and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General*, *132*, 310–324. doi:10.1037/0096-3445.132.2.310

Conway, M. A., & Dewhurst, S. A. (1995). The self and recollective experience. *Applied Cognitive Psychology*, *9*, 1–19. doi:10.1002/acp.2350090102

Conway, M. A., Dewhurst, S. A., Pearson, N., & Sapute, A. (2001). The self and recollection reconsidered: How a "failure to replicate" failed and why trace strength accounts of recollection are untenable. *Applied Cognitive Psychology*, *15*, 673–686. doi:10.1002/acp.740

Craik, F. I. M. (1977). Age differences in human memory. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 384–420). New York, NY: Van Nostrand Reinhold.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behaviour*, *11*, 671–684. doi:10.1016/S0022-5371(72)80001-X

Craik, F. I. M., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*, 474–479. doi:10.1037/0278-7393.13.3.474

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, *104*, 268–294. doi:10.1037/0096-3445.104.3.268

Davidson, P. S. R., Cook, S. P., & Glisky, E. L. (2006). Flashbulb memories of September 11th can be preserved in older adults. *Neuropsychological Development and Cognition, Series B: Ageing, Neuropsychology, and Cognition*, *13*, 196–206. doi:10.1080/13825580490904192

Dulas, M. R., Newsome, R. N., & Duarte, A. (2011). The effects of aging on ERP correlates of source memory retrieval for self-referential information. *Brain Research*, *1377*, 84–100. doi:10.1016/j.brainres.2010.12.087

Fernandes, M., Ross, M., Wiegand, M., & Schryer, E. (2008). Are the memories of older adults positively biased? *Psychology and Aging*, *23*, 297–306. doi:10.1037/0882-7974.23.2.297

Fossati, P., Hevenor, S. J., Graham, S. J., Grady, C., Keightley, M. L., Craik, F., & Mayberg, H. (2003). In search of the emotional self: An fMRI study using positive and negative emotional words. *American Journal of Psychiatry*, *160*, 1938–1945. doi:10.1176/appi.ajp.160.11.1938

Fossati, P., Hevenor, S. J., Lepage, M., Graham, S. J., Grady, C., Keightley, M. L., … Mayberg, H. (2004). Distributed self in episodic memory: Neural correlates of successful retrieval of self-encoded positive and negative personality traits. *NeuroImage*, *22*, 1596–1604. doi:10.1016/j.neuroimage.2004.03.034

Fotopoulou, A., Conway, M. A., Solms, M., Tyrer, S., & Kopelman, M. (2008). Self-serving confabulation in prose recall. *Neuropsychologia*, *46*, 1429–1441. doi:10.1016/j.neuropsychologia.2007.12.030

Gardiner, J. M., & Richardson-Klavehn, A. (2000). Remembering and knowing. In E. Tulving, & F. I. M. Craik (Ed.), *The Oxford handbook of memory* (pp. 229–244). New York, NY: Oxford University Press.

Genon, S., Bahri, M. A., Collette, F., Angel, L., d'Argembeau, A., Clarys, D., … Bastin, C. (2014). Cognitive and neuroimaging evidence of impaired interaction between self and memory in Alzheimer's disease. *Cortex*, *51*, 11–24. doi:10.1016/j.cortex.2013.06.009

Gilboa, A. (2004). Autobiographical and episodic memory—one and the same?: Evidence from prefrontal activation in neuroimaging studies. *Neuropsychologia*, *42*, 1336–1349. doi:10.1016/j.neuropsychologia.2004.02.014

Glisky, E. L., & Marquine, M. (2009). Semantic and self-referential processing of positive and negative trait adjectives in older adults. *Memory*, *17*, 144–157. doi:10.1080/09658210802077405

Grilli, M. D., & Glisky, E. L. (2010). Self-imagining enhances recognition memory in memory-impaired individuals with neurological damage. *Neuropsychology*, *24*, 698–710. doi:10.1037/a0020318

Grilli, M. D. & Glisky, E. L. (2011). The self-imagination effect: Benefits of a self-referential encoding strategy on cued recall in memory-impaired individuals with neurological damage. *Journal of the International Neuropsychological Society*, *17*, 929–933. doi:10.1017/S1355617711000737

Grilli, M. D., & Glisky, E. L. (2013). Imagining a better memory: Self-imagination in memory-impaired patients. *Clinical Psychological Science*, *1*, 93–99. doi:10.1177/2167702612456464

Grühn, D., Smith, J., & Baltes, P. B. (2005). No aging bias favoring memory for positive material: Evidence from a heterogeneity–homogeneity list paradigm using emotionally toned words. *Psychology and Aging*, *20*, 579–588. doi:10.1037/0882-7974.20.4.579

Gutchess, A. H., Kensinger, E. A., Yoon, C., & Schacter, D. L. (2007). Ageing and the self-reference effect in memory. *Memory*, *15*, 822–837. doi:10.1080/09658210701701394

Hamami, A., Serbun, S. J., & Gutchess, A. H. (2011). Self-referencing enhances memory specificity with age. *Psychology and Aging*, *26*, 636–646. doi:10.1037/a0022626

Hultsch, D., & Dixon, R. (1984). Memory for text materials in adulthood. In P. Baltes & Q. Brim, Jr. (Ed.), *Life-span development and behavior* (6th ed., pp. 77–108). New York, NY: Academic Press.

Jacoby, L. L., Yonelinas, A. P., & Jennings, J. M. (1997). The relation between conscious and unconscious (automatic) influences: A declaration of independence. In E. Jonathan, D. Cohen, & W. Schooler (Eds.), *Scientific approaches to consciousness* (pp. 13–47). Hillsdale, NJ: Erlbaum.

Java, R. I. (1996). Effects of age on state of awareness following implicit and explicit word association tasks. *Psychology and Aging*, *11*, 108–111. doi:10.1037/0882-7974.11.1.108

Kensinger, E. A. (2009). How emotion affects older adults' memories for event details. *Memory*, *17*, 208–219. doi:10.1080/09658210802221425

Kensinger, E. A., Garoff-Eaton, R. J., & Schacter, D. L. (2007). Effects of emotion on memory specificity in young and older adults. *Journals of Gerontology. Series B: Psychological Sciences and Social Sciences*, *62*, P208–P215. doi:10.1093/geronb/62.4.P208

Kensinger, E. A., Krendl, A. C., & Corkin, S. (2006). Memories of an emotional and a nonemotional event: Effects of aging and delay interval. *Experimental Aging Research*, *32*, 23–45. doi:10.1080/01902140500325031

Kensinger, E. A., & Schacter, D. L. (2006). When the Red Sox shocked the Yankees: Comparing negative and positive memories. *Psychonomic Bulletin and Review*, *13*, 757–763. doi:10.3758/BF03193993

Kropf, N. P., & Tandy, C. (1998). Narrative therapy with older clients. *Clinical Gerontologist*, *18*, 3–16. doi:10.1300/J018v18n04_02

Leshikar, E. D., & Duarte, A. (2014). Medial prefrontal cortex supports source memory for self-referenced materials in young and older adults. *Cognitive, Affective, & Behavioral Neuroscience*, *14*, 236–252. doi:10.3758/s13415-013-0198-y

Leshikar, E. D., Dulas, M. R., & Duarte, A. (2014). Self-referencing enhances recollection in both young and older adults. *Aging, Neuropsychology, and Cognition*. doi:10.1080/13825585.2014.957150

Levine, B., Svoboda, E. M., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging*, *17*, 677–689. doi:10.1037/0882-7974.17.4.677

Levine, L. J., & Bluck, S. (2004). Painting with broad strokes: Happiness and the malleability of event memory. *Cognition and Emotion*, *18*, 559–574. doi:10.1080/02699930341000446

Light, L. L., Prull, M. W., La Voie, D. J., & Healy, M. R. (2000). Dual-process theories of memory in old age. In T. J. Perfect & E. A. Maylor (Eds.), *Models of cognitive aging: Debates in psychology* (pp. 238–300). New York, NY: Oxford University Press.

Luis, C. A., Keegan, A. P., & Mullan, M. (2009). Cross validation of the Montreal cognitive assessment in community dwelling older adults residing in the Southeastern US. *International Journal of Geriatric Psychiatry*, *24*, 197–201. doi:10.1002/gps.2101

Mäntylä, T. (1993). Knowing but not remembering: Adult age differences in recollective experience. *Memory & Cognition*, *21*, 379–388. doi:10.3758/BF03208271

Mar, R. A., Peskin, J., & Fong, K. (2011). Literary arts and the development of the life story. *New Directions for Child and Adolescent Development*, *131*, 73–84.

Mather, M., & Carstensen, L. L. (2005). Ageing and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences*, *9*, 496–502. doi:10.1016/j.tics.2005.08.005

McDermott, K. B., Szpunar, K. K., & Christ, S. E. (2009). Laboratory-based and autobiographical retrieval tasks differ substantially in their neural substrates. *Neuropsychologia*, *47*, 2290–2298. doi:10.1016/j.neuropsychologia.2008.12.025

Mickley, K. R., & Kensinger, E. A. (2008). Emotional valence influences the neural correlates associated with remembering and knowing. *Cognitive, Affective, & Behavioral Neuroscience*, *8*, 143–152. doi:10.3758/CABN.8.2.143

Miller, P. J. (1995). Personal storytelling in everyday life: Social and cultural perspectives. In R. S. Wyer (Ed.), *Knowledge and memory: The real story* (pp. 177–184). Hillsdale, NJ: Erlbaum.

Mueller, J. H., Wonderlich, S., & Dugan, K. (1986). Self-referent processing of age-specific material. *Psychology and Ageing*, *1*, 293–299. doi:10.1037/0882-7974.1.4.293

Murphy, N. A., & Isaacowitz, D. M. (2008). Preferences for emotional information in older and younger adults: A meta-analysis of memory and attention tasks. *Psychology and Aging*, *23*, 263–286. doi:10.1037/0882-7974.23.2.263

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., … Chertkow, H. (2005). The Montreal cognitive assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society*, *53*, 695–699. doi:10.1111/j.1532-5415.2005.53221.x

Olofsson, M., & Backman, L. (1993). Predictors of prose recall in adulthood and old age. *Archives of Gerontology and Geriatrics*, *16*, 129–140. doi:10.1016/0167-4943(93)90004-2

Ozubko, J. D., & Yonelinas, A. P. (2012). A familiar finding: Pseudowords are more familiar but no less recollectable than words. *Journal of Memory and Language*, *66*, 361–375. doi:10.1016/j.jml.2011.11.002

Piolino, P., Desgranges, B., Clarys, D., Guillery-Girard, B., Tacconat, L., Isingrini, M., & Eustache, F. (2006). Autobiographical memory, autonoetic consciousness, and self-perspective in aging. *Psychology and Aging*, *21*, 510–525. doi:10.1037/0882-7974.21.3.510

Piolino, P., Desgranges, B., & Eustache, F. (2009). Episodic autobiographical memories over the course of time: Cognitive, neuropsychological and neuroimaging findings. *Neuropsychologia*, *47*, 2314–2329. doi:10.1016/j.neuropsychologia.2009.01.020

Reeder, G. E., McCormick, C. B., & Esselman, E. D. (1987). Self-referent processing and recall of prose. *Journal of Educational Psychology*, *79*, 243–248. doi:10.1037/0022-0663.79.3.243

Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology*, *35*, 677–688. doi:10.1037/0022-3514.35.9.677

Rosa, N. M., & Gutchess, A. H. (2011). Source memory for action in young and older adults: Self vs. close or unknown others. *Psychology and Aging*, *26*, 625–630. doi:10.1037/a0022827

Rossetti, H. C., Lacritz, L. H., Cullum, C. M., & Weiner, M. (2011). Normative data for the montreal cognitive assessment (MoCA) in a population-based sample. *Neurology*, *77*, 1272–1275. doi:10.1212/WNL.0b013e318230208a

Schacter, D. L., Gaesser, D., & Addis, D. R. (2013). Remembering the past and imagining the future in the elderly. *Gerontology*, *59*, 143–151. doi:10.1159/000342198

Serbun, S. J., Shih, J. Y., & Gutchess, A. H. (2011). Memory for details with self-referencing. *Memory*, *19*, 1004–1014. doi:10.1080/09658211.2011.626429

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: A meta-analysis. *Psychological Bulletin*, *121*, 371–394. doi:10.1037/0033-2909.121.3.371

Trelle, A. N., Henson, R. N., & Simons, J. S. (2015). Identifying age-variant and age-limited mechanisms for enhanced memory performance: Insights from self-referential processing in younger and older adults. *Psychology and Aging*. doi:10.1037/a0039116

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology*, *26*, 1–12. doi:10.1037/h0080017

Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, *53*, 1–25. doi:10.1146/annurev.psych.53.100901.135114

Wechsler, D. (1997). *Wechsler adult intelligence scale-third edition* (*WAIS-III*). San Antonio, TX: Psychological Corporation.

Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence* (*WASI*). San Antonio, TX: The PsychologicalCorporation.

Wolters, G., & Goudsmit, J. J. (2005). Flashbulb and event memory of September 11, 2001: Consistency, confidence and age effects. *Psychological Report*, *96*, 605–619. doi:10.2466/PR0.96.3.605-619

Xu, J., Kennedy, S., Park, G., Frattali, C., & Braun, A. (2005). Language in context: Emergent features of word, sentence, and narrative comprehension. *NeuroImage*, *25*, 1002–1015. doi:10.1016/j.neuroimage.2004.12.013

Yarkoni, T., Speer, N. K., & Zacks, J. M. (2008). Neural substrates of narrative comprehension and memory. *NeuroImage*, *41*, 1408–1425. doi:10.1016/j.neuroimage.2008.03.062

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, *46*, 441–517. doi:10.1006/jmla.2002.2864

Yonelinas, A. P., & Jacoby, L. L. (1995). The relation between remembering and knowing as bases for recognition: Effects of size congruency. *Journal of Memory and Language*, *34*, 622–643. doi:10.1006/jmla.1995.1028

Zelinski, E., Light, L., & Gilewski, M. (1984). Adult age differences in memory for prose: The question of sensitivity to passage structure. *Developmental Psychology*, *20*, 1181–1192. doi:10.1037/0012-1649.20.6.1181

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale (HADS). *Acta Psychiatrica Scandinavica*, *67*, 361–370. doi:10.1111/j.1600-0447.1983.tb09716.x

Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin*, *123*, 162–185. doi:10.1037/0033-2909.123.2.162

Appendix 1

Generation and scoring of narratives

Sample of narrative generation according to the autobiographical interview scoring procedure (Levine et al., 2002). According to this procedure, details central to the story ("internal details") are specified according to type of information conveyed, including event, time, place, perceptual, and thought/emotion details. Each generated narrative was matched on the number and types of internal details.

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. I
thought/emotion thought/emotion
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.

Sample of scoring key for narrative cued recall scoring:

Element from story "New Baby"	For point
(1) My cousin gave birth to a baby girl	Indication that someone had a baby
(2) on Mother's Day.	Mother's Day
(3) She was so tiny	Indication of small size of baby (synonyms of "tiny" accepted)
(4) and her skin was pink.	Indication of skin appearance, variations on the colour pink accepted
(5) I was nervous about the delivery	Indication of worry (synonyms of "nervous" accepted)
(6) so I was thrilled upon hearing that both the baby and mother were doing well.	Indication of happiness (synonyms of "thrilled" accepted)
(7) I immediately went to visit them.	Indication that went to see mother and baby

Example of recalled narrative in response to the title "New Baby", scored using scoring key:

I was happy (#6—1 point) and *I went right away to the hospital* (#7—1 point) and it was *Mother's Day* (#2—1 point) when the *baby was born* (#1—1 point) and yes I went to visit them at the hospital.

Appendix 2

Comparison of narrative recognition items in Experiments 1 and 2

Items presented at recognition in Experiment 1 included an entire narrative and accompanying title, whereas in Experiment 2, only a short phrase was presented without a title. In both recognition paradigms, there were stimuli presented from the studied narratives, distractor narratives matched for theme but with novel content, and distractor narratives with novel themes and content.

Examples of stimuli presented during the narrative recognition test:

	Studied narrative	Distractor narrative *Same theme but novel content*	Distractor narrative *Novel theme and content*
Experiment 1 (title included)	New Baby 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.	New Baby My younger brother was born on my birthday, 7 May. I thought he was going to be a girl, so I was really surprised to suddenly have a baby brother. He was a large baby, and felt heavy in my arms. I knew we would be great friends from that moment on.	Won Lottery I won $50,000 in the lottery last week. It was one of those "Scratch & Win" cards with gold edges. I was jumping up and down in utter disbelief that I had won. I thought about all the expensive things I would buy and the places I would go.
Experiment 2 (title not included)	My cousin gave birth to a baby girl	I was surprised to suddenly have a baby brother	I won $50,000 in the lottery