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Semantic and self-referential processing of positive and negative trait adjectives in older adults

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The beneficial effects of self-referential processing on memory have been demonstrated in numerous experiments with younger adults but have rarely been studied in older individuals. In the present study we tested young people, younger-older adults, and older-older adults in a self-reference paradigm, and compared self-referential processing to general semantic processing. Findings indicated that older adults over the age of 75 and those with below average episodic memory function showed a decreased benefit from both semantic and self-referential processing relative to a structural baseline condition. However, these effects appeared to be confined to the shared semantic processes for the two conditions, leaving the added advantage for self-referential processing unaffected These results suggest that reference to the self engages qualitatively different processes compared to general semantic processing. These processes seem relatively impervious to age and to declining memory and executive function, suggesting that they might provide a particularly useful way for older adults to improve their memories.

Numerous studies in young adults have demonstrated that the processing of information in relation to the self enhances memory relative to semantic processing or processing in relation to another person—what has been termed the "self-reference effect" (SRE; for review, see Symons & Johnson, 1997). Although this effect has been found reliably across different materials, modalities, and a variety of conditions, some exceptions have emerged—for example, processing in reference to an intimate other often produces an equally beneficial effect—and these have prompted a variety of different interpretations of the phenomenon. In the seminal paper on the SRE, Rogers, Kuiper, and Kirker (1977) proposed that the self functioned as a "superordinate schema" to assist in the encoding, processing, interpretation, and retrieval of personal information. The advantage for self-referential (SR) processing was not just attributable to more semantic processing but instead reflected access to a qualitatively different, well-developed structure—the self schema—that would allow extensive elaboration of stimuli and multiple routes for retrieval. Other researchers, however, have challenged this view and suggested that the benefit of SR processing is not a result of any special mnemonic properties of the self per se, but instead is simply a consequence of ordinary memory mechanisms, namely the greater elaboration and organisation of information that occurs when processing is in reference to the self (e.g., Klein & Kihlstrom, 1986; Klein & Loftus, 1988). This view postulates that if processing is elaborate and organisational, such as might also occur when one considers whether or not an adjective describes one's mother for example, memory should be equally enhanced in these conditions. A related view (e.g., Bower & Gilligan, 1979) suggests that the crucial element is the existence

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of a well-differentiated information structure. Here again the key comparison is not self versus non-self but well-known person versus other kinds of semantic information.

Another explanation that has been suggested concerns the affective component of SR judgements (Miall, 1986). Considerable evidence attests to the power of emotion to enhance memory (e.g., Bradley, Greenwald, Petry, & Lang, 1992; Davidson, McFarland, & Glisky, 2006; Kensinger & Corkin, 2003; Reisberg & Heuer, 2003). Because SR processing may typically evoke emotion, this too might be a contributor to the memory benefits associated with the SRE. A related idea is that any evaluative judgement, such as deciding whether a certain trait is desirable, will enhance memory, and there is evidence to support this view as well (Ferguson, Rule, & Carlson, 1983; Gutchess, Kensinger, Yoon, & Schacter, 2007).

The debate concerning whether the self is special has also extended to studies examining the neural correlates of SR processing, with some studies proposing specific neural circuitry associated with the processing of self-relevant information, and others suggesting that these brain circuits may support something broader than self processing, for example, person processing or processing of emotional information (for review, see Gillihan & Farah, 2005). The brain regions that have most often been associated with SR processing include cortical midline structures both in frontal (e.g., Amodio & Frith, 2006; Craik et al., 1999; Fossati et al., 2003; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Northoff et al., 2006; Schmitz & Johnson, 2006) and parietal cortex (Lou et al., 2004; Northoff et al., 2006; Schmitz & Johnson, 2006). These same regions, however, are often activated in “other” processing and in the processing of emotion (Amodio & Frith, 2006; Ochsner et al., 2004), and so have not provided solid evidence concerning the special status of the self (see Gillihan & Farah, 2005).

In contrast to SR processing, deep semantic processing that is not self-relevant has been shown to activate left inferior prefrontal cortex and lateral temporal cortex (for review, see Cabeza & Nyberg, 1997; Gabrieli et al., 1996; Kapur et al., 1994; Schmitz & Johnson, 2006; Wagner, 2002) rather than medial structures. In addition, studies that have contrasted self-referent and other-referent judgements have often found these same lateral brain structures activated in both tasks, suggesting that access to general semantic information occurs when judgements about either the self or other are made (Craik et al., 1999; Kelley, 2002).

The neuroimaging studies, like the behavioural studies, have not been able to adjudicate between the two most popular interpretations of the SRE: (a) the self has special mnemonic properties or (b) processing in relation to the self simply allows information to be encoded more elaborately. One possible interpretation of existing findings is that processing of stimuli such as trait adjectives requires access to semantic memory structures for any orienting task related to meaning. Thus SR, other-referential, and general semantic tasks should all activate the left inferior prefrontal and lateral temporal brain regions that are associated with deep semantic processing. Additional judgements about the relation of the stimulus to the self or an intimate other would require access to more specific schemata.

In an attempt to provide information relevant to this issue and with a goal of discovering ways to enhance memory in brain-injured individuals, we tested a group of memory-impaired neurological patients in a SR paradigm (Marquine & Glisky, 2005) in which we looked at recognition of trait adjectives following SR processing, general semantic processing, and a baseline structural level of processing. We found that despite general memory deficits, most patients could benefit from either semantic processing or self-referential processing, or both. Of particular interest was the finding that the size of the SRE was correlated with prefrontal function in patients although the semantic processing effect was not, consistent with the notion that the SRE depends not just on more elaborate semantic processes but on qualitatively different processes associated with the self. In addition, some patients showed greater benefits for semantic than SR processing, providing further evidence that the two tasks involved qualitatively different processes.

Virtually all of the studies on the SRE, both behavioural and neuroimaging, have involved younger adults only. In an early study of older adults (mean age = 67 years), Mueller, Wonderlich, and Dugan (1986) found, in a recall test, that older people exhibited a SRE for trait adjectives (relative to an other-reference condition) that was of approximately the same size as that found in younger adults, although their overall level of performance was somewhat lower. A similar finding was recently reported by Gutchess et al. (2007) in recognition memory. Thus, SR processing appears to be intact in older adults. The Gutchess et al. study also provided preliminary evidence concerning individual differences in the SRE, demonstrating that older adults who performed poorly on speed of processing measures benefited less from SR processing than faster performers. The authors proposed that processing speed reflected the availability of cognitive resources, and that those older adults with fewer resources were less able to benefit from SR processing. However, the processing speed measure in their study was also related to age and education, and in prior studies has been found to be correlated with memory and executive function (Park et al., 2002). Thus, the implications of this finding with respect to the mechanisms underlying the SRE remain uncertain.

We were interested in exploring further whether the benefits of SR processing might accrue to a particular subset of older adults, namely those with good executive function, consistent with our previous findings that the SRE was correlated with prefrontal function in memory-impaired patients. Evidence from both cognitive neuropsychological and neuroimaging studies of older adults suggests that normal ageing is associated with declining function in prefrontal cortex (for reviews, see Park & Gutchess, 2005; Raz, 2000, 2005), although there is considerable variability. One might hypothesise, then, that older adults with reduced executive function may benefit less from SR processing to the extent that it depends on prefrontal brain regions. Older people also show relatively intact emotional processing and emotion regulation (Mather & Knight, 2005; Reminger, Kaszniak, & Dalby, 2000; Williams et al., 2006), processes that have been associated with medial frontal brain structures, and exhibit preserved memory enhancement effects for emotional stimuli (Davidson et al., 2006; Denburg, Buchanan, Tranel, & Adolphs, 2003). To the extent that SR processing involves emotional components, older adults should show normal benefits, particularly for positively valenced self traits. Consistent with theories of socioemotional selectivity (Carstensen, Fung, & Charles, 2003), considerable recent evidence points to a positivity effect in older adults, whereby positive emotional experiences and stimuli are remembered better than negative (Charles, Mather, & Carstensen, 2003; Mather & Carstenson, 2005). Thus, if emotion plays a specific role in the SRE, benefits for older adults may be greater for positive than negative traits.

Many people also experience more general memory declines as they get older such that episodic memory is increasingly impaired with advancing years (for reviews, see Glisky, 2007; Kester, Benjamin, Castel, & Craik, 2002; Zacks, Hasher, & Li, 2000), although again there is substantial variability. It may be that if basic memory function is compromised, older adults will be less likely to benefit from mnemonic strategies, including SR processing (see Glisky & Glisky, 2008). Evidence consistent with this view comes from studies that have found that, although instructions to process information semantically generally improve memory in older adults, the age deficit is not always eliminated (Craik, 2002). One interpretation of this finding is that some older people may have deficits in semantic processing, which results in less semantically elaborated or less distinctive memory traces. If this were the case, one might expect to see impairments in episodic memory in older people following both semantic and SR processing. On the other hand, if the self has special mnemonic properties over and above the elaborative and organisational properties associated with semantic processing, and the self-representation remains intact in older people, SR processing may still provide a benefit.

In the present study we used a recognition task to investigate the effects of deep semantic processing and SR processing in young adults and two groups of older adults: a younger-older group, aged 66–75 years, and an older-older group, aged 76–91 years. All older participants had been characterised according to neuropsychological tests as above or below average on executive function and memory function. Most studies of memory and ageing have not distinguished between younger-older and older-older groups, focusing instead on the younger cohort. However, recent evidence from longitudinal studies (Rönnlund, Nyberg, Bäckman, & Nilsson, 2005) suggests that although episodic memory impairments in older adults appear to begin, on average, around the age of 60 and decline sharply thereafter, significant declines in semantic memory may not occur until beyond the age of 75. Thus, if semantic memory deficits play a role in episodic memory by reducing the degree of elaboration or distinctiveness of memory traces, these effects are more likely to be observed in the older-older group.

A number of hypotheses were tested in the present study. First, on the basis of previous research (Gutchess et al., 2007; Mueller et al., 1986), we expected that our younger-older adult group (of similar age to participants in previous studies) would benefit from both semantic and SR processing, with SR processing being the superior of the two. We speculated, however, that our older-older adults might show a reduced ability to benefit from semantic and SR processing because of semantic processing deficits. Second, we predicted that the beneficial effect of SR processing might be dependent on good executive function (Marquine & Glisky, 2005). Third, we considered that there might also be an effect of basic memory ability, namely that those with poor memory function might benefit less than those with good memory function. Fourth, consistent with Carstensen and colleagues' findings of a positivity effect in older adults, we expected that older people might show better memory for positive trait adjectives than negative trait adjectives across all conditions, an effect that might be enhanced in the SR condition.

METHOD

Participants

A total of 48 older adults between the ages of 66 and 91 years participated in the study. Older adults were recruited from our laboratory pool of healthy, community-dwelling adults, with no history of neurological problems or current psychiatric illness or alcohol or substance abuse. Each individual in the pool had completed a battery of neuropsychological tests within 2 years of experimental testing. Two groups of tests have been identified through factor analysis, one representing executive functions associated with the frontal lobes (the FL factor), and the other representing memory functions associated with the medial temporal lobes (the MTL factor) (Glisky, Polster, & Routhieaux, 1995; Glisky, Rubin, & Davidson, 2001; Glisky & Kong, in press).

The tests contributing to the FL factor include number of completed categories on the modified Wisconsin Card Sorting Test (WCST; Hart, Kwentus, Wade, & Taylor, 1988), the total number of words generated in a word fluency test, using initial letters F, A, and S (Spreen & Benton, 1977), the Mental Arithmetic subtest from the Wechsler Adult Intelligence Scale–Revised (WAIS-R; Wechsler, 1981), and Mental Control, and Backward Digit Span from the Wechsler Memory Scale–Third Edition (WMS-III; Wechsler, 1997). The group of tests comprising the MTL factor include Logical Memory I first recall, Faces I and Verbal Paired Associates I from the WMS-III (Wechsler, 1997), Visual Paired Associates II from the Wechsler Memory Scale–Revised (WMS-R; Wechsler, 1987), and the Long-Delay Cued Recall measure from the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987).

Based on their neuropsychological testing performance, individuals in the pool had been assigned two scores, one representing executive function, and the other memory function. The composite scores for each individual represent average *z* scores for those tests loading on each factor, after variance attributable to age was removed, relative to a 227-member normative group (see Glisky & Kong, in press). For the present study older adults were selected on the basis of their neuropsychological test performance as high (i.e., above the mean) or low (i.e., below the mean) on the two composite measures. FL factor scores ranged from –1.59 to $+1.64$, and MTL scores ranged from –1.68 to $+1.12$, Characteristics of participants as a function of FL and MTL group are presented in Table 1. One-way between-participants analyses of variance (ANOVAs) indicated that the high and low FL groups differed significantly on their composite FL scores, but not on their MTL scores, while MTL groups differed significantly on their composite MTL scores, but not on FL scores. There were also no differences between groups on age, education, and raw scores from the Vocabulary subtest of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). The probability of a Type I error was set at .05 for all statistical comparisons.

Older adults were divided post-hoc into two subgroups on the basis of their age. Because previous research has shown that older adults do not begin to show declines in semantic memory until over the age of 75 (Rönnlund et al., 2005), that age was chosen as an appropriate point at which to divide the older group. A total of 25 older adults between the ages of 66 and 75 years old (age $M = 71.4$ years, $SD = 2.72$; education $M = 15.88$, $SD = 2.24$) comprised the younger-older group, and 23 older adults between ages 76 and 91 years old (age $M = 80.9$, $SD = 4.08$; education $M = 15.61$, $SD = 2.57$) comprised the older-older group. A between-participants ANOVA on years of education, FL and MTL scores revealed that these age groups did not differ significantly on any of these variables (all $F\text{s} \leq 0.15$, $p\text{s} \geq .69$).

TABLE 1
Characteristics of older adults as a function of MTL and FL group

	MTL function				FL function			
	Low (n = 24)		High (n = 24)		Low (n = 24)		High (n = 24)	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age	75.5	5.9	76.5	5.9	75.4	6.4	76.6	5.4
Education	16.0	2.4	15.5	2.4	15.1	2.1	16.4	2.6
Vocabulary[a]	66.4	6.9	68.2	6.0	65.6	6.4	68.9	6.3
MTL Score[b]	−.63	.43	.62	.24	−.06	.79	.05	.66
FL Score[b]	−.00	.79	.05	.93	−.73	.42	.78	.36

MTL = medial temporal lobe; FL = frontal lobe.
[a] Raw scores from the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999). [b] z scores (see text).

A total of 48 young adults between the ages of 18 and 27 (age $M = 19.73$, $SD = 2.00$; education $M = 12.54$, $SD = 1.05$) were recruited from undergraduate psychology classes at the University of Arizona.

Materials

Four lists of trait adjectives were created: three target lists of 24 words each to be presented during the learning phase, and one distractor list of 72 words to be used for recognition testing. Each of the three target lists constituted a block within a continuous 72-item study list, bounded by two primacy and two recency buffers. Words were selected from a pool of normalised personality trait adjectives (Anderson, 1968). Trait words were all moderate to highly meaningful with meaningfulness ratings ranging from 326 to 386 ($M = 358$). The three target lists were equated for word length, (i.e., mean number of letters = 8) and valence, such that each list was composed of half positive and half negative traits. In Anderson's (1968) list, words were ordered according to their likeability ratings. In the present study a word was considered positive if it was one of the first 252 words listed in the list and negative if it had a ranking between 253 and 555. The mean ranking for positive words was 97 and the mean ranking for negative words was 391. The distractor list was matched on the same variables to the group of three target lists.

Procedure

Participants were assessed individually, and gave informed consent before participating in experimental procedures. There were two parts to the study, an incidental learning phase and an immediate recognition memory test phase. During the learning phase, the participants' task was to answer a question about each of the target words. Each list was encoded under one of three conditions: SR, semantic, and structural encoding. In the SR encoding task participants judged whether trait adjectives were self-descriptive by answering the question "Does this word describe you?" In the semantic encoding task participants made valence judgements on a semantic dimension, answering the question "Is the dictionary definition of this word positive?" Under the structural encoding task participants were asked, "Is this word typed in upper case letters?"

Participants were presented with 72 words, consisting of the three target lists blocked by encoding task. Presentation was blocked by condition for two reasons: First, the constant switching between tasks might adversely affect performance in older people and second, a pilot study suggested that carry-over effects might occur in mixed lists, particularly in older adults. However, order of encoding tasks was counterbalanced so that each task appeared in each ordinal position an equal number of times, and across participants, target lists appeared equally often in each of the three conditions. Word order was randomised within each list, and each participant received a different random order.

Participants were seated in front of a computer where the procedure was explained to them. On each trial one of the questions defining the learning task (e.g. "Does this word describe you?") was presented on the computer screen for 2 s, after which an adjective appeared for 4 s, and participants made a yes/no response by pressing one of two keys on the computer keyboard. A blank screen was then displayed for 1 s and the next trial appeared automatically.

Following the study phase, there was a 2-minute interval in which people engaged in an unrelated distractor task, and then a yes–no recognition memory test was given. The recognition test consisted of 144 words, half targets and half distractors, randomly mixed (i.e., not blocked by condition), which were presented one at a time on the computer screen. Participants indicated whether each word was old or new. Each item remained on the screen until participants pressed one of two keys to indicate if they recognised the word as one that had been previously presented.

RESULTS

Recognition and age

Mean false alarm rates across the three age groups differed significantly: young adults = .10, younger-older adults = .14, and older-older adults = .20, $F(2, 93) = 11.8$, $p < .001$, $\eta_p^2 = .20$. All recognition memory results are therefore shown and analysed in terms of hits minus false alarms (“corrected recognition”) unless otherwise noted. Figure 1 shows the mean proportion of items correctly recognised for each encoding condition (structural, semantic, and SR) as a function of age (i.e., young, younger-older and older-older adults). A 3 × 3 mixed model ANOVA revealed a main effect of encoding task, $F(2, 186) = 289.27$, $p < .001$, $\eta_p^2 = .76$, a main effect of age group, $F(2, 93) = 14.05$, $p < .001$, $\eta_p^2 = .23$, and a significant interaction, $F(4, 186) = 2.69$, $p < .05$, $\eta_p^2 = .06$. Analysis of the simple main effects of condition indicated that SR encoding led to significantly better recognition than semantic encoding, which in turn produced better recognition than structural encoding (all ps < .001) across all age groups. Analysis of the simple main effects of age indicated that age groups did not differ in the baseline structural condition, $F(2, 93) = 2.02$, $p > .10$, but differed in both the semantic, $F(2, 93) = 10.89$, $p < .001$ and SR conditions, $F(2, 93) = 15.53$, $p < .001$. Subsequent pairwise comparisons indicated that the younger-older group was not significantly different from the young group (ps > .05), and both outperformed the older-older group in the semantic and SR conditions (ps < .005).

Recognition and neuropsychological groups

Figure 2 presents the recognition results across encoding tasks for the high and low FL and MTL groups along with the young data. A 3 (task) × 3 (group) mixed ANOVA comparing young adults and the two FL groups showed a main effect of encoding task, $F(2, 186) = 283.40$, $p < .001$, $\eta_p^2 = .75$, a main effect of group, $F(1, 93) = 8.77$, $p < .001$, $\eta_p^2 = .16$, but no interaction $F(4, 186) = 1.28$, $p = .28$. Subsequent comparisons indicated no differences between the high and low FL groups ($p = .59$), and both groups performed more poorly than the young group ($p < .01$). The ANOVA comparing young adults and the two MTL groups provided a somewhat different outcome: Although there was a significant main effect of encoding task, $F(2, 186) = 301.59$, $p < .001$, $\eta_p^2 = .76$, and a main effect of group, $F(2, 93) = 12.19$, $p < .001$, $\eta_p^2 = .21$, there was also a significant interaction, $F(4, 186) = 4.35$, $p < .01$, $\eta_p^2 = .09$. An

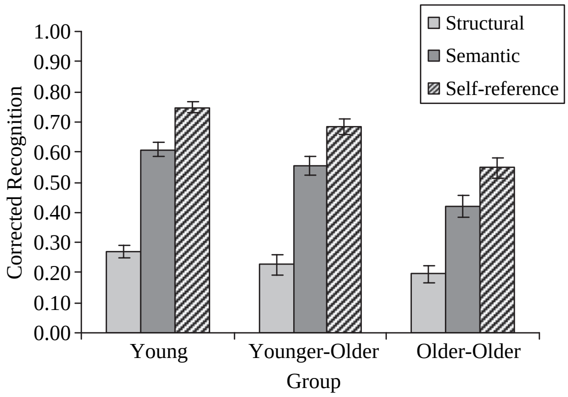

Figure 1. Corrected recognition (hits minus false alarms) as a function of age group and encoding task (Mean + SE)

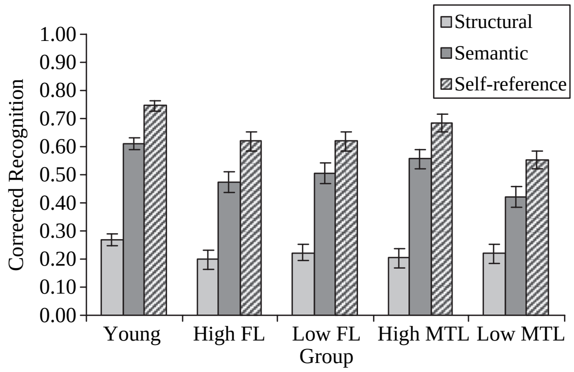

Figure 2. Corrected recognition (hits minus false alarms) as a function of FL group, MTL group and encoding task (Mean + SE)

analysis of the simple main effects of group indicated no differences in the structural encoding condition, $F(2, 93) = 1.82$, $p > .10$, but differences in the semantic, $F(2, 93) = 10.87$, $p < .001$, and SR conditions, $F(2, 93) = 14.88$, $p < .001$. Subsequent pairwise comparisons indicated that the young and high MTL groups did not differ and both were superior to the low MTL group (ps < .05).

Semantic & SR effects as a function of age and MTL group

To explore further the beneficial effects of semantic and SR processing in relation to age and memory function among the older adults, we performed a 2 (younger-older vs. older-older adults) × 2 (high vs low MTL group) × 2 (semantic vs SR processing) mixed ANOVA on the SR and levels of processing (LOP) effects (subtracting the structural baseline). These data are presented in Table 2. The analysis indicated that there were three main effects but no interactions: Younger-older adults recognised more trait adjectives than older-older adults, $F(1, 44) = 5.10$, $p < .05$, $\eta_p^2 = .10$, the high-MTL older group recognised more than the low-MTL group, $F(1, 44) = 9.30$, $p < .01$, $\eta_p^2 = .18$, and SR processing resulted in better memory performance than semantic processing, $F(1, 44) = 44.35$, $p < .001$, $\eta_p^2 = .50$.

In all of the analyses thus far the SRE has been significantly greater than the LOP effect and both have been assessed relative to the structural baseline condition. To the extent that both tasks require basic semantic processing, the specific contribution of SR processing might better be evaluated in terms of the additional benefit of SR relative to the semantic processing condition. A visual inspection of Figures 1 and 2 suggests that the advantage of SR over semantic processing is constant across all groups, whereas the LOP effect varies across age and MTL function as described above. This pattern can be seen clearly in Table 3. A 2 × 2 ANOVA assessing the effect of age (younger-older vs older-older adults) and MTL on the effect specific to SR processing relative to the semantic condition (SR-Semantic) confirmed the observation that the additional benefit for SR processing was equivalent across age and MTL groups (all $Fs \leq 1$).

To test whether the reduced LOP effect in the older-older adults might be attributable to semantic processing deficits, we examined whether this group was impaired relative to the younger-older group in category fluency (e.g., Benton, Hamsher, & Sivan, 1994), a task requiring the generation of instances from three different categories (animals, fruits or vegetables, and names) each within a 1-minute interval. As predicted, the older-older group ($M = 50.1$, $SD = 10.8$) scored significantly lower than the younger-older group ($M = 59.8$, $SD = 13.1$) on the measure of category fluency, $t(46) = 2.77$, $p = .008$.

Recognition as a function of item valence

Table 4 shows the proportion of positive and negative study items that were given "yes" responses on the recognition test for each of the three age groups. Preliminary analyses indicated that valence did not interact with task and so results are collapsed across the three encoding conditions. A 3 (age) × 2 (valence) ANOVA on correctly identified items (i.e., hits) indicated a

TABLE 2
Levels of processing (LOP) effect and self-reference effect (SRE) relative to a structural processing baseline

	Age group	
MTL group	*Younger-older*	*Older-older*
	LOP	
High[a]	.43 (.14)	.28 (.17)
Low	.23 (.27)[b]	.17 (.13)[c]
	SRE	
High[a]	.57 (.16)	.39 (.17)
Low	.35 (.25)[b]	.31 (.06)[c]

The values represent mean proportions (*SD*s). MTL = medial temporal lobe. [a]$n = 12$; [b]$n = 13$; [c]$n = 11$.

TABLE 3
Levels of processing (LOP) effect relevant to the structural baseline and the additional benefit of self-referential processing (SR-semantic)

Group	*n*	*LOP*	*SR-semantic*
Young	48	.34 (.16)	.14 (.16)
Younger-older	25	.33 (.23)	.13 (.13)
Older-older	23	.23 (.16)	.13 (.13)
High MTL	24	.35 (.17)	.13 (.12)
Low MTL	24	.20 (.21)	.13 (.14)

Values represent mean proportions (*SDs*). LOP = semantic minus structural condition; SR-Semantic = self-reference minus semantic condition; MTL = medial temporal lobe.

TABLE 4
Mean proportions (*SD*s) of hits and false alarms (FAs) across age groups as a function of valence

	Hits		*FAs*		*Hits – FAs*	
Age group	*Positive*	*Negative*	*Positive*	*Negative*	*Positive*	*Negative*
Young	.65 (.02)	.62 (.02)	.15 (.09)	.04 (.04)	.50 (.11)	.57 (.13)
Younger-older	.68 (.03)	.56 (.03)	.21 (.09)	.07 (.08)	.48 (.11)	.49 (.16)
Older-older	.70 (.03)	.49 (.03)	.30 (.17)	.10 (.11)	.40 (.14)	.39 (.21)

main effect of valence, $F(1, 93) = 84.8$, $p < .001$, $\eta_p^2 = .48$, such that positive items were recognised more often than negative items. However, this effect interacted with age, $F(2, 93) = 16.05$, $p < .001$, $\eta_p^2 = .26$. Analysis of the simple main effects indicated that the differences between positive and negative items occurred for all age groups. However, there were no differences across age groups for positively valenced items, $F(2, 93) = 1.07$, $p = .35$, but there was a significant difference across age groups for negatively valenced items, $F(2, 93) = 6.15$, $p = .003$, such that the older-older adults recognised significantly fewer negative adjectives than did the young adult group ($p = .001$) and marginally fewer negative items than the younger-older adults ($p = .07$). A similar analysis of false alarm rates showed a main effect of age, $F(2, 93) = 11.8$, $p < .001$, $\eta_p^2 = .20$, a main effect of valence, $F(1, 93) = 164.36$, $p < .001$, $\eta_p^2 = .64$, and an interaction, $F(2, 93) = 5.36$, $p = .006$, $\eta_p^2 = .10$. Overall, false alarm rates were higher for positively valenced distractor items than negative items and the number of false alarms to positive items increased significantly with age (all ps $< .03$). False alarm rates for negative items were also significantly higher in the older-older group relative to the young group ($p = .02$), but overall, false alarm rates to negative items were quite low. For both hits and false alarms, the difference in the number of "yes" responses between positive and negative items increased with age. Interestingly, as can be seen in Table 4, when false alarms were subtracted from hits, the recognition memory benefit for positive items disappeared. A 3 × 2 ANOVA on the corrected recognition scores indicated no main effect of valence, a main effect of age, $F(2, 93) = 11.9$, $p < .001$, $\eta_p^2 = .20$, and a marginally significant interaction, $F(2, 93) = 2.73$, $p = .07$, $\eta_p^2 = .06$. Only the young group showed a difference in memory as a function of valence, with negative items being recognised significantly more often than positive items, $t(47) = 3.96$, $p < .001$. Both older groups showed equivalent memory for positive and negative items in corrected recognition. There were no differences in recognition of positive and negative adjectives as a function of neuropsychological groups.

Recognition as a function of encoding response

In order to explore whether people were more likely to remember trait adjectives that they endorsed, we computed the proportion of correctly identified items that were answered affirmatively and negatively during learning across the three conditions (see Table 5), and conducted a 3 (age group) × 3 (encoding task) × 2 (encoding response: "yes" or "no") ANOVA on recognition hits. The key aspects of this analysis concern the effects of response and the interactions of response with the other variables. The analysis showed a significant main effect of response $F(1, 93) = 32.30$, $p < .001$, $\eta_p^2 = .26$, such that those items that were given "yes" responses during the encoding tasks were subsequently remembered better than those given "no" responses. However, this effect interacted both with task, $F(2, 186) = 16.16$, $p < .001$, $\eta_p^2 = .15$ and age group, $F(2, 93) = 3.25$, $p < .05$, $\eta_p^2 = .07$. Subsequent analysis of the response by task interaction indicated that the advantages for semantic and SR processing occurred for both "yes" and "no" encoding responses, but the advantages were slightly larger for items that had received "yes" responses. In addition, performance in the structural condition did not differ as a function of response, but "yes" responses were remembered better than "no" responses in both the semantic and SR conditions, $t(95) = 3.86$ and 6.17 respectively, ps $< .001$). Given that there were no differences in the structural condition, we re-analysed the data for the semantic and SR conditions only. In this analysis, task did not interact with response, indicating that the yes/no effect was equivalent across the

TABLE 5
Mean proportions (*SD*s) of recognition hits as a function of study response

	Structural		*Semantic*		*Self-reference*	
Group	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*
Young	.36 (.16)	.37 (.19)	.72 (.18)	.68 (.19)	.88 (.13)	.80 (.22)
Younger-older	.34 (.22)	.39 (.22)	.73 (.16)	.64 (.20)	.91 (.09)	.73 (.22)
Older-older	.42 (.24)	.41 (.23)	.70 (.21)	.52 (.23)	.83 (.19)	.67 (.21)
High MTL	.34 (.20)	.36 (.21)	.75 (.12)	.63 (.17)	.91 (.13)	.73 (.16)
Low MTL	.42 (.26)	.44 (.23)	.67 (.22)	.54 (.25)	.84 (.17)	.66 (.26)

MTL = medial temporal lobe.

semantic and SR encoding tasks, and that the advantage of SR relative to LOP was statistically equivalent for the "yes" and "no" responses. However, the response by age group interaction persisted, $F(2,\ 93) = 4.92$, $p = .009$, $\eta_p^2 = .10$. Further analyses indicated that there were no age differences for "yes" responses, $F(2, 93) = 1.06$, *ns*, but significant age differences for "no" responses, $F(2, 93) = 5.67$, $p = .005$, such that the older-older adults were impaired relative to young adults, $t\ (69) = 3.33$, $p = .001$, in recognition of items that had received "no" responses to the semantic and SR encoding questions. Recognition performance for items receiving "yes" and "no" responses for the MTL groups are also shown at the bottom of Table 5. Analyses of these data showed a similar task by response interaction, but no interaction between response and group.

DISCUSSION

The present study replicated previous findings showing that older adults exhibit a normal SRE in memory for trait adjectives, and extended the study of SRE in older adults in several ways. First, the experiment reported here used a recognition test and compared SR processing to semantic processing rather than to processing with respect to other people, showing that the effect in older adults is robust not only across testing formats but also across different comparison conditions (but see Gutchess et al., 2007, Experiment 3 for an exception). Second, the effects of semantic and SR processing were examined in several subgroups of older adults, including those over age 75, and those with varying levels of basic memory and executive functioning. Findings were consistent with the idea that the advantage provided by access to a self-representation (or perhaps a well-known person representation) is only partly affected by the same variables that affect semantic processing. Specifically, older age (i.e., over 75) and reduced episodic memory function affected the ability to benefit from semantic processing, but did not influence the additional benefit gained from SR processing. If one assumes that the semantic processing necessary to decide whether an adjective represents a positive or negative attribute is shared by the semantic and SR processing conditions, then variables that affect semantic processing should also affect SR processing, as was shown when each effect was assessed relative to a structural processing baseline. However, when the SRE was assessed relative to the LOP effect, these same variables had no additional impact on the size of the SRE. Although it is possible that the additional benefit of SR processing reflects additional semantic or more elaborate processing, we think it more likely that SR processing results in memory traces that are qualitatively different from those that are elaborated semantically, enriched by SR information or a self-schema that is relatively resistant to ageing. This interpretation is consistent with neuroimaging studies indicating that semantic and SR encoding processes activate similar regions of left inferior prefrontal cortex and lateral temporal cortex (Craik et al., 1999; Kelley, 2002), but SR judgements additionally activate midline brain structures. Further, these midline structures appear less susceptible to the effects of normal ageing (Salat et al., 2004). A qualitative distinction is also more consistent with previous findings in brain-damaged patients (Marquine & Glisky, 2005), showing better memory for SR processing in some patients but for semantic processing in others.

Previous studies with older adults (Gutchess et al., 2007; Mueller et al., 1986) tested relatively young groups of older participants (mean age = 69–71 and 67 yrs respectively). Thus it seemed possible that the failure to find age-related deficits in the SRE in those studies may have been attributable to the young age of the older adults. In the present study we divided our older adults into a younger-older group with a mean age of 71 yrs and an older-older group with a mean age of 81 yrs. When compared to a common baseline, both the LOP effect and the SRE were preserved in the younger-older group but showed impairments in the older-older group. We speculate that this reduced benefit in the oldest group might be attributable to declining semantic processing abilities with advancing years. This view was supported by the finding of lower levels of category (i.e., semantic) fluency in the older-older adults relative to the younger-older group, despite the fact that the two groups were matched for education. However, although age had a negative effect on general semantic processing, the additional SR processing benefit was not reduced in the older-older group attesting to the robustness of the effect even into very old age.

We had expected, on the basis of findings from neuroimaging studies and our previous work with brain-injured patients (Marquine & Glisky, 2005), that SR processing would engage prefrontal brain regions, and that the SRE would be dependent on executive function. However, we found no differences between the high and low FL groups in the extent to which they benefited from either semantic or SR processing. This outcome may reflect the complexity of the frontal lobes and the diversity of functions associated with them, and suggests that, to the extent that the SRE depends on the FLs, it relies on regions different from those that support the tasks in our FL factor. Although the precise functions associated with the FL factor are still undetermined, we have suggested elsewhere (Glisky & Kong, in press; Glisky et al., 2001) that they may involve the initiation of processing activities that serve to integrate and manipulate multiple components of an experience in working memory, tasks that engage primarily dorsolateral prefrontal brain regions. SR processing, on the other hand, has been associated with medial prefrontal brain structures and may therefore not depend on the functions associated with our FL factor. Brain-injured patients in our previous study tended to have diffuse lesions affecting broad areas of prefrontal and temporal cortex, which may have accounted for the correlation of the SRE with executive function in those individuals.

Although we did not find an effect of executive function in this study, it may be that processes associated with the FL factor would be important if specific encoding instructions were not provided and recall tests given. Craik (1986, 2005) has argued that age-related deficits in memory are reduced as environmental support is increased. This may be particularly important for those with declining executive function, who may fail to initiate the deep semantic or self-referential processes that enhance memory, unless instructed to do so. However, when orienting tasks cue those processes, the frontal lobes may not be needed. In addition, trait adjectives may lend themselves rather naturally to SR processing, and this may further obviate the need for frontal involvement.

The ability to benefit from semantic and SR processing, however, seemed to be at least partly dependent on basic memory function. Older people with below average scores on the MTL factor showed reduced LOP and SR effects relative to baseline. This effect was independent of age, and may reflect reduced consolidation or binding problems in people with poor memory function. This finding thus places boundary conditions on levels of processing and SR benefits. If memory deficits stem from fundamental problems in binding or memory storage, providing deep semantic or SR encoding strategies may have limited benefit.

Two other findings are worth mentioning: Items given positive responses during semantic and SR encoding were more likely to be recognised later. This yes/no effect has been observed before in levels of processing studies (Craik & Tulving, 1975) and has been interpreted in terms of the greater or richer elaboration made possible by items that fit the orienting questions compared to those that do not. It has also been observed in previous SRE studies (e.g., Kuiper & Rogers, 1979) where it was interpreted as evidence that the self functions as a schema. A possible explanation for the advantage of SR processing over semantic processing could therefore be the greater number of "yes" responses in the SR condition than in the semantic condition. This occurs because "yes" and "no" responses are distributed approximately equally in the semantic condition but not in the SR condition where people tend to endorse as self-referent more positive than negative adjectives. However, although there were more "yes" responses in the SR condition than in the semantic condition, the SRE relative to the LOP effect was equivalent for "yes" and "no" responses, suggesting that this difference could not account for the SR advantage.

It was also found that the yes/no effect was exaggerated in the older-older adults, who had significantly more difficulty than young adults recognising items that had received "no" responses during encoding. These "no" items, which did not match the orienting question, may have been particularly difficult for the older-older adults to elaborate semantically because of semantic processing difficulties. Thus, the memory traces for these items may have been of poor quality and thereby less likely to be retrieved. However, this same problem did not occur in the low MTL group, which showed equivalent deficits for items receiving "yes" and "no" responses, suggesting that the problem for the low MTL individuals was not primarily one of semantic processing.

The last finding of interest concerns the effect of valence. Considerable evidence has suggested a positivity bias in older adults, such that positive stimuli are more likely to be remembered than negative stimuli (Mather & Carstensen, 2005). This outcome has been interpreted in terms of socioemotional selectivity theory (Carstensen et al., 2003), whereby as people age they tend to optimise their experiences by attending more to positive than to negative events. This effect was evident in the present experiment. For all groups, positive items had higher hit rates than negative items, but with increasing age there was a significant reduction in the hit rate for negative items, but no age differences in the hit rate for positive items. However, false alarm rates for positive items were also significantly higher than for negative items, and this effect too increased with age. These findings are consistent with the, notion that as people get older, they pay increasing attention to positive experiences. However, as evidenced by the corrected recognition scores (hits minus false alarms), this does not necessarily result in overall better recognition memory for positive than negative items. In fact, the high false alarm rates for positive items suggest that discriminating positive targets from positive lures is particularly difficult for older adults, possibly because these encodings appear less distinctive against a background of similar positive events. Thus, although positive stimuli may attract greater attention from older adults, this information is not necessarily processed more deeply. This idea is consistent with recent findings from a study by Kensinger, Garoff-Eaton, and Schacter (2007), who found that older adults but not younger had enhanced recognition for the gist of positive stimuli compared to neutral stimuli—in this case pictures of objects—but no better memory for the details. This finding suggests that positive stimuli are encoded rather generically, lacking the level of detail necessary for them to be distinguished from positively valenced lures. Thus, the advantage of increased attention to positive events at encoding in older adults may be offset by the lack of discriminating detail available at retrieval. Negative items, on the other hand, may not attract the same attention during encoding, but appear to be encoded more specifically (Kensinger et al., 2007), making them more discriminable at time of test. These two offsetting processes may result in no differences in recognition memory for positive and negative adjectives in older adults, when hits are corrected for false alarms. The advantage for negative stimuli in young adults, on the other hand, may be attributable both to an attentional bias during encoding and to a more detailed memory trace, which is readily discriminable from similar lures at retrieval.

Two final points: One concerns the suggestion in the literature (Mather & Carstensen, 2005) that the positivity effect might depend on encoding tasks and be greater when processing is personally relevant and emotionally important. We did not obtain that result in this study. The valence effects were virtually identical across conditions, suggesting that the stimuli themselves carried the effect, which was not enhanced by SR processing. Second, given that more positive than negative items were endorsed in the SR condition, could this account for the valence effect? Although we could not test this directly because of missing data for several individuals (i.e., they did not endorse any negative items), again the finding that the valence effects were equivalent across all conditions, whereas the endorsement effects differed across conditions, argues against this possibility.

Although not conclusive, the present study adds further support to the view that the self is special, at least relative to general semantic processing. It may also be that other people, particularly those well-known to the individual (e.g., one's mother or spouse), would provide similar advantages for memory because of the extent of personal knowledge known about them. This hypothesis was not tested in the present study although it has been supported in past studies (e.g., Bower & Gilligan, 1979; Czienskowski & Giljohann, 2002; Keenan & Baillet, 1980). Further, it appears that the SRE remains intact well into the upper years of life, even in the face of declining executive and memory functions, suggesting that self-referential processing may provide a particularly useful way for older adults to improve their memories.

REFERENCES

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: The medial frontal cortex and social cognition. *Nature Reviews Neuroscience*, *7*, 268–277.

Anderson, N. H. (1968). Likeableness ratings of 555 personality-trait words. *Journal of Personality and Social Psychology*, *9*, 272–279.

Benton, A. L., Hamsher, K., de, S., & Sivan, A. B. (1994). *Multilingual Aphasia Examination* (3rd ed). San Antonio, TX: Psychological Corporation.

Bower, G. H., & Gilligan, S. G. (1979). Remembering information related to one's self. *Journal of Research in Personality*, *13*, 420–432.

Bradley, M. M., Greenwald, M. K., Petry, M. C., & Lang, P. J. (1992). Remembering pictures: Pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, Cognition*, *18*, 379–390.

Cabeza, R., & Nyberg, L. (1997). Imaging cognition: An empirical review of PET studies with normal subjects. *Journal of Cognitive Neuroscience*, *9*, 1–26.

Carstensen, L. L., Fung, H. F., & Charles, S. T. (2003). Socioemotional selectivity theory and the regulation of emotion in the second half of life. *Motivation and Emotion*, *27*, 103–123.

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.

Craik, F. I. M. (1986). A functional account of age differences in memory. In F. Klix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities, mechanisms and performances* (pp. 409–422). Amsterdam: Elsevier.

Craik, F. I. M. (2002). Human memory and ageing. In L. Bäckman & C. von Hofsten (Eds.), *Psychology at the turn of the millennium* (Vol. 1 pp. 261–280). Hove, UK: Psychology Press.

Craik, F. I. M. (2005). On reducing age-related declines in memory and executive control. In J. Duncan, P. McLeod, & L. Phillips (Eds.), *Measuring the mind: Speed, control and age*. Oxford, UK: Oxford University Press.

Craik, F. I. M., Moroz, T. M., Moscovitch, M., Stuss, D. T., Winocur, G., Tulving, E., et al. (1999). In search of the self: A positron emission tomography study. *Psychological Science*, *10*, 26–34.

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.

Czienskowski, U., & Giljohann, S. (2002). Intimacy, concreteness, and the "self-reference effect. *Experimental Psychology*, *49*, 73–79.

Davidson, P. S. R., McFarland, C. P., & Glisky, E. L. (2006). Effects of emotion on item and source memory in young and older adults. *Cognitve, Affective, & Behavioral Neuroscience*, *6*, 306–322.

Delis, D. C., Kramer, J., Kaplan, E., & Ober, B. A. (1987). *The California Verbal Learning Test*. San Antonio, TX: Psychological Corporation.

Denberg, N. L., Buchanan, T. W., Tranel, D., & Adolphs, R. (2003). Evidence for preserved emotional memory in normal older persons. *Emotion*, *3*, 239–253.

Ferguson, T. J., Rule, G. R., & Carlson, D. (1983). Memory for personally relevant information. *Journal of Personality and Social Psychology*, *44*, 251–261.

Fossati, P., Hevenor, S. J., Graham, S. J., Grady, C. L., Keightley, M. L., Craik, F., et al. (2003). In search of the emotional self: An fMRI study using positive and negative emotional words. *American Journal of Psychiatry*, *160*, 1938–1945.

Gabrieli, J. D. E., Desmond, J. E., Demb, J. B., Wagner, A. D., Stone, M. V., Vaidya, C. J., et al. (1996). Functional magnetic resonance imaging of semantic memory processes in the frontal lobes. *Psychological Science*, *7*(5), 278–283.

Gillihan, S. J., & Farah, M. J. (2005). Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience. *Psychological Bulletin*, *131*, 76–97.

Glisky, E. L. (2007). Changes in cognitive function in human ageing. In D. R. Riddle (Ed.), *Brain ageing: Models, methods, and mechanisms* (pp. 3–20). Boca Raton, FL: CRC Press.

Glisky, E. L., & Glisky, M. L. (2008). Memory rehabilitation in older adults. In D. Stuss, G. Winocur, & I. Robertson (Eds.), *Cognitive neurorehabilitation: Evidence and applications* (2nd ed., pp. 541–562). Cambridge, UK: Cambridge University Press.

Glisky, E. L., & Kong, L. L. (in press). Do young and older adults rely on different processes in source memory tasks? A neuropsychological study. *Journal of Experimental Psychology: Learning, Memory, and Cognition.*

Glisky, E. L., Polster, M. R., & Routhieaux, B. C. (1995). Double dissociation between item and source memory. *Neuropsychology*, *9*(2), 229–235.

Glisky, E. L., Rubin, S. R., & Davidson, P. S. R. (2001). Source memory in older adults: An encoding or retrieval problem? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*, 1131–1146.

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

Hart, R. P., Kwentus, J. A., Wade, J. B., & Taylor, J. R. (1988). Modified Wisconsin Card Sorting Test in elderly normal, depressed and demented patients. *Clinical Neuropsychologist*, *2*, 49–56.

Kapur, S., Craik, F. I. M., Tulving, E., Wilson, A., Houle, S., & Brown, G. M. (1994). Neuroanatomical correlates of encoding in episodic memory: Levels of processing effect. *Proceedings of the National Academy of Sciences USA*, *91*, 2008–2011.

Keenan, J. M., & Baillet, S. D. (1980). Memory for personally and socially significant events. In R. S. Nickerson (Ed.), *Attention and performance* (Vol. 8 pp. 651–659). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Kelley, W. M. (2002). Finding the self? An event-related fMRI study. *Journal of Cognitive Neuroscience*, *14*, 785–794.

Kensinger, E. A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition*, *31*, 1169–1180.

Kensinger, E. A., Garoff-Eaton, R., & Schacter, D. L. (2007). Effects of emotion on memory specificity in young and older adults. *Journal of Gerontology: Psychological Sciences*, *62B*, P208–P215.

Kester, J. D., Benjamin, A. S., Castel, A. D., & Craik, F. I. M. (2002). Memory in elderly people. In A. D. Baddeley, M. D. Kopelman, & B. A. Wilson (Eds.), *The handbook of memory disorders* (2nd ed., pp. 543–567). Chichester, UK: Wiley.

Klein, S. B., & Kihlstrom, J. F. (1986). Elaboration, organisation, and the self-reference effect in memory. *Journal of Experimental Psychology: General*, *115*, 26–38.

Klein, S. B., & Loftus, J. (1988). The nature of self-referent encoding: The contributions of elaborative and organisational processes. *Journal of Personality and Social Psychology*, *55*, 5–11.

Kuiper, N. A., & Rogers, T. B. (1979). Encoding of personal information: Self–other differences. *Journal of Personality and Social Psychology*, *37*, 499–514.

Lou, H. C., Luber, B., Crupain, M., Keenan, J. P., Nowak, M., Kjaer, T. W., et al. (2004). Parietal cortex and representation of the mental self. *Proceedings of the National Academy of Sciences*, *101*, 6827–2832.

MacPherson, S. E., Phillips, L. H., & Della Sala, S. (2002). Age, executive function and social decision making: A dorsolateral prefrontal theory of cognitive ageing. *Psychology & Ageing*, *17*, 598–609.

Macrae, C. N., Moran, J. M., Heatherton, T. F., Banfield, J. F., & Kelley, W. M. (2004). Medial prefrontal activity predicts memory for self. *Cerebral Cortex*, *14*, 647–654.

Marquine, M. J., & Glisky, E. L. (2005). *Self-knowledge and the self-reference effect in memory-impaired individuals.* Paper presented at the International Neuropsychological Society, St. Louis, MO.

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

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Ageing*, *20*, 554–570.

Miall, D. S. (1986). Emotion and the self: The context of remembering. *British Journal of Psychology*, *77*, 389–397.

Mueller, J. H., Wonderlich, S., & Dugan, K. (1986). Self-referent processing of age-specific material. *Psychology and Ageing*, *4*, 293–299.

Northoff, G., Heinzel, A., de Greck, M., Bermpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain–A meta-analysis of imaging studies on the self. *NeuroImage*, *31*, 440–457.

Ochsner, K. N., Knierim, K., Ludlow, D. H., Hanelin, J., Ramachandran, T., Glover, G., et al. (2004). Reflecting upon feelings: An fMRI study of neural systems supporting the attribution of emotion to self and other. *Journal of Cognitive Neuroscience*, *16*, 1746–1772.

Park, D. C., & Gutchess, A. H. (2005). Long-term memory and ageing: A cognitive neuroscience perspective. In R. Cabeza, L. Nyberg, & D. Park (Eds.), *Cognitive neuroscience of ageing* (pp. 218–245). Oxford, UK: Oxford University Press.

Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and Ageing*, *17*, 299–320.

Raz, N. (2000). Ageing of the brain and its impact on cognitive performance: Integration of structural and functional findings. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of ageing and cognition* (pp. 1–90, 2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates Inc.

Raz, N. (2005). The ageing brain observed in vivo: Differential changes and their modifiers. In R. Cabeza, L. Nyberg, & D. Park (Eds.), *Cognitive neuroscience of ageing* (pp. 19–57). Oxford, UK: Oxford University Press.

Reisberg, D., & Heuer, F. (2003). Memory for emotional events. In D. Reisberg & P. Hertel (Eds.), *Memory and emotion* (pp. 3–41). New York: Oxford University Press.

Reminger, S. L., Kaszniak, A. W., & Dalby, P. (2000). Age-invariance in the asymmetry of stimulus-evoked emotional facial muscle activity. *Ageing, Neuropsychology, and Cognition*, *7*, 156–168.

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.

Rönnlund, M., Nyberg, L., Bäckman, L., & Nilsson, L-G. (2005). Stability, growth, and decline in adult life span development of declarative memory: Cross-sectional and longitudinal data from a population-based study. *Psychology and Ageing*, *20*, 3–18.

Ryff, C. D. (1991). Possible selves in adulthood and old age: A tale of shifting horizons. *Psychology and Ageing*, *6*, 286–295.

Salat, D. H., Buckner, R. L., Snyder, A. Z., Greve, D. N., Desikan, R. S. R., Busa, E., et al. (2004). Thinning of the cerebral cortex in ageing. *Cerebral Cortex*, *14*, 721–730.

Schmitz, T. W., & Johnson, S. C. (2006). Self-appraisal decisions evoke dissociated dorsal-ventral aMPFC networks. *NeuroImage*, *30*, 1050–1058.

Spreen, O., & Benton, A. L. (1977). *Neurosensory Center Comprehensive Examination for Aphasia* (revised ed.). Victoria, BC: University of Victoria Neuropsychology Laboratory.

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

Wagner, A. D. (2002). Cognitive control and episodic memory. In L. R. Squire & D. L. Schacter (Eds.), *Neuropsychology of memory* (3rd ed) (pp. 174–192). New York: Guilford Press.

Wechsler, D. (1981). *Wechsler Adult Intelligence Scale–Revised*. New York: Psychological Corporation.

Wechsler, D. (1997). *Wechsler Memory Scale–III*. San Antonio, TX: Psychological Corporation.

Wechsler, D. (1987). *Wechsler Memory Scale–Revised*. New York: Psychological Corporation.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence*. San Antonio, TX: Psychological Corporation, Harcourt Brace.

Williams, L. M., Brown, K. J., Palmer, D., Liddell, B. J., Kemp, A. H., Olivieri, G., et al. (2006). The mellow years?: Neural basis of improving emotional stability over age. *The Journal of Neuroscience*, *26*, 6422–6430.

Zacks, R. T., Hasher, L., & Li, K. Z. H. (2000). Human memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of ageing and cognition* (2nd ed pp. 293–357). Mahwah, NJ: Lawrence Erlbaum Associates Inc.