Self as a moderator of age-related deficit on Recollection

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ABSTRACT

In recognition memory, older participants report fewer occasions when recognition is accompanied by recollection of the original encoding context. Impaired encoding has been proposed as one of the main determinants of the age-related differences in recollective experience. This study was designed to investigate whether older adults could take advantage of the self-reference effect at encoding to boost recollection and compensate for their deficit. A group of 20 young adults and a group of 20 older adults encoded target words either through self-reference or by giving a general definition, and then performed a recognition test in which they classified their responses according to Gardiner et al.'s (1999) remember-know-guess paradigm. The results show that age-related differences in recollection disappeared when the information was encoded in terms of the self. In sum, the older adults took advantage of self-reference encoding to enhance their ability to recall information consciously.

Le Soi comme modérateur des effets de l'âge sur la Remémoration

RÉSUMÉ

Lors de la reconnaissance d'une information en mémoire, les sujets âgés reconnaissent moins d'informations en se remémorant le contexte d'encodage d'origine. Un déficit d'encodage a été proposé comme un des principaux déterminants des différences liées à l'âge sur la remémoration. Cette étude a été menée afin de voir si les sujets âgés pouvaient bénéficier de l'encodage en référence à soi pour augmenter la remémoration d'une information et ainsi compenser leurs déficits. Un groupe de 20 sujets jeunes et un

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groupe de 20 sujets âgés ont encodé des mots soit en référence à soi, soit en donnant une définition générale du mot, puis ont été soumis à un test de reconnaissance associant le paradigme Remember/Know de Gardiner et al. (2009). Les résultats ont montré que les différences liées à l'âge sur la remémoration disparaissaient lorsque l'information était encodée en référence à soi. En conclusion, il apparait que les personnes âgées bénéficient de l'encodage en référence à soi pour augmenter leur habileté à récupérer une information en accédant consciemment au contexte d'encodage.

1. INTRODUCTION

Aging leads to a deterioration of episodic memory. One way of examining the effects of age on episodic memory is to look at the subjective states associated with memory retrieval. A number of studies on recognition memory have indicated that people experience at least two quite distinct states of awareness that evaluate the quality of recognition. First, "remembering" involves recalling contextual details of previous events and experiences, including an awareness of one's self, usually at a particular time and in a particular place. Secondly, "knowing" does not involve remembering as such, but is more an abstract awareness of general knowledge. According to Tulving (1985), these two states of awareness reflect autonoetic and noetic consciousness respectively, which in turn reflect two mind / brain systems, i.e. episodic and semantic memory (see also Wheeler, Stuss, & Tulving, 1997). It is assumed that subjective reports of these two mental states can be measured with the Remember-Know paradigm (Gardiner, 1988) which is used to assess the conscious states accompanying recollection and familiarity. In this paradigm, participants are given a recognition memory test and instructed to assign their positive recognition decisions to either "Remember" (R) responses if they can consciously recollect the item's study presentation, or "Know" (K) responses if they recognize the item on the basis of familiarity but cannot consciously recollect its study presentation.

In the aging literature, findings from different paradigms indicate that aging disrupts recollection to a greater extent than familiarity (see Yonelinas, 2002). Of particular interest to our study, experiments using the Remember/Know paradigm (Tulving, 1985) have shown an age-related decrease in remembering (i.e., R responses), and in most cases no effect on knowing (Bugaiska et al., 2007; Clarys, Bugaiska, Tapia, & Baudouin, 2009; Parkin & Walter, 1992). One possible explanation of the difference in R responses between younger and older adults concerns an age-related decrease in strategic encoding (Craik, 1986; 1990). In order to test the

hypothesis that impaired encoding is an important determinant of the age-related differences in recollective experience, a number of studies have investigated the effect of the depth of encoding in aging. Using depth-of-processing instructions to encode words (either counting vowels or forming an image), Perfect, Dasgupta and Anderton-Brown (1995, experiment 2) showed that in the condition requiring formation of an image there was no difference between the recollective experience of older and younger adults. They suggested that older adults do not spontaneously engage in elaborative encoding. According to the environmental support view (Craik, 1986, 1990), older participants do not spontaneously implement processes that assist memorization, but can do so when given appropriate tasks. On the basis of this model, it can be assumed that the various operations carried out in a memorization task can be divided into task-driven and self-initiated processing. It is the latter, which requires great attention that causes older adults the greatest difficulty. A useful strategy for enhancing the memory performance of older participants would be to increase the task-driven part of the operations at learning and retrieval by providing environmental support to compensate for this processing deficit.

Several studies have examined whether factors known to increase Remember responses in young participants also influence Remember responses in older adults. A condition known to increase recollection, and particularly Remember responses, is *Self-Reference* at encoding (Conway, Dewhurst, Pearson, & Sapute, 2001). The *Self-Reference effect* (SRE) refers to the improvement of memory by encoding words with reference to the self, rather than encoding them on a semantic or physical basis (Rogers, Kuiper, & Kirker, 1977).

An association with the self is inherent in the characterization of the phenomenological experience of recollection. A sense of the self in the past is an important feature of recollective experience (Conway, 2000). Using the Remember/Know paradigm, studies have demonstrated an SRE on remembering but not on knowing (Conway et al., 2001; Van den Bos, Cunningham & Turk, 2010). Studies on aging have found that older adults benefit from the process of self-referencing in the same way as young adults (Glisky & Marquine, 2009; Gutchess, Kensinger, Yoon, & Schacter, 2007). More recently, several studies have assessed the self-reference effect in aging on objective measures of recollection. For example, Dulas, Newsome and Duarte (2011) asked participants to judge the pleasantness (self-referential encoding) or commonness of a series of pictured items. During recognition, as well as identifying which pictures had been shown at encoding, participants were asked which judgment they had made for the item (thereby testing source memory). Although

older adults showed lower overall recognition accuracy than young adults, self-referential encoding did improve the performance of older adults both for recognition of previously studied items and for memory of the source of those items. This observed enhancement of source retrieval has since been replicated with similar materials (Hamami, Serbun, & Gutchess, 2011), with trait adjectives (Hamami et al., 2011), and also with actions performed by the self, a close other or a stranger (Rosa & Gutchess, 2011). Two recent studies on Alzheimer's disease (Genon et al., 2013; Kalenzaga, Bugaiska, & Clarys, 2013) demonstrated that patients could benefit from self-reference encoding to enhance recollection, but to a lesser extent than healthy older adults. To the best of our knowledge, no studies have yet tested the effect of self-reference on the subjective states of recollection in older compared to young adults.

The novelty of this study was to investigate whether self-referential encoding attenuates age-related differences in recollective experience during an episodic memory task using the R/K paradigm. We contrasted a condition where participants had to produce a general definition of an adjective with another condition where they had to produce a definition in self-reference. The SRE is thought to arise as a consequence of the enrichment and organization of incoming information through the framework of stored autobiographical knowledge (for review, see Symons & Johnson, 1997). In sum, studies indicate that, although age effects on objective measures of recollection cannot be removed by self-referential encoding (Dulas et al., 2011; Hamami et al., 2011; Rosa & Gutchess, 2011), older adults are able to benefit from the SRE to a similar extent as young adults. With evidence of an SRE on objective measures of recollection in aging, we thus predicted that subjective states of recollection in older adults would also benefit from the self-reference effect. Therefore, we hypothesized that older adults would benefit from the self-reference effect at encoding, boosting recollection and more specifically the number of R responses.

2. METHOD

2.1. Participants and Background Measures

Forty participants were divided into two groups: 20 young adults (10 women and 10 men) aged 20-35 years, and 20 older adults (10 women and 10 men) aged 65-85 years. All the older participants lived at home and no participants were taking medication likely to affect their intellectual abilities. They scored above the cut-off of 27 points on the Mini Mental State Examination (MMSE-Folstein, Folstein & Mc Hugh, 1975).

Table 1. Means and standard deviations of participants'
characteristics for the two age groups

	Young (n = 20)		Old (n = 20)		
	M	**SD**	**M**	**SD**	**F(1.38)**
Age (in years)	23.37	3.16	70.96	7.67	
MMSE	–	–	29.83	0.48	
Education (years)	13.41	2.08	11.87	4.46	2.35 NS
Mill Hill	25	3.14	27.37	4.88	3.65 NS

Note. NS: Not Significant.

The demographic characteristics of the two groups are shown in Table 1. The groups did not differ in years of education or verbal ability on the French version of the Mill-Hill test (Deltour, 1993).

2.2. Material and Design

Participants performed an encoding task and a recognition task using the Remember/Know/Guess procedure (Gardiner, Ramponi, & Richardson-Klavehn, 1999). They were tested individually and were informed that the experiment involved memory measures.

2.2.1. Encoding

Two lists of 40 trait adjectives were selected from the Brulex database (Content, Mousty, & Radeau, 1990). The two lists were matched for frequency and length and were similar (all Fs < 1). One set was presented at encoding, and the words in this set were used as target items in the following recognition test, while the other set provided the lures. Half the participants were presented with one list, half with the other. The two lists were divided into two. For half the participants, list 1 was assigned to the Self-Reference condition and list 2 to the general definition condition, and for the other half, list 1 was assigned to the general definition condition and list 2 to the Self-Reference condition. Words were presented on a computer screen with Microsoft Power Point for 5 seconds with an inter-stimulus period of two seconds, under two conditions: under the general definition condition, participants were asked to produce a general definition of 20 words (e.g. selfish: "someone who cares too much about himself and not enough about others"); under the self-reference condition, participants had to produce a short self-reference definition of the other 20 words (e.g. selfish: "I am selfish because I care about myself but not about others", or "I am not selfish because I care about others and not only about myself"). Half the adjectives were positive and the other half were negative. After receiving instructions and practice on the encoding tasks, participants intentionally encoded adjectives and were told that they had to

memorize the words for a subsequent test. Half the participants began with the self-reference condition and half with the general definition condition. Participants responded orally.

2.2.2. Remember/Know/Guess paradigm

The test phase was introduced after a retention interval of 5 minutes. During this interval, the participants carried out a back-counting task. For the recognition test, all 80 words (40 targets and 40 lures) were presented one by one, and for each word that was recognized the participants had to indicate whether their response was based on remembering (R), knowing (K) or guessing (G).

Participants were instructed to give an R response if the adjective evoked a specific recollection of the learning sequence, for example it brought to mind a particular association, image, or some other personal experience, or they recalled something about its appearance or position. K responses were to be given when participants felt confident about recognizing the adjective but without any such specific learning experience. G responses were to be used when they were not sure whether they had seen the adjective in the study list. After the recognition test, participants were asked to explain at least two of their Remember and two of their Know judgments, to ensure that they had used the two responses correctly. For R responses, they had to be able to give episodic details associated with encoding the adjectives, and for K responses, they had to indicate that they recognized the adjective but could not remember any specific detail about learning it. No participants were excluded on the basis of their explanations. The participants were given the vocabulary test a few minutes after the end of the session.

The dependent variables were based on the absolute proportions (#hits/#targets for correct recognition, and #false alarms/#lures for false alarms) for overall recognition, R and K judgments. Guess responses were not analyzed separately because they were only used to enhance the quality of K responses (see Conway et al., 2001). The dependent variables were submitted to a 2 (age group: young vs. old adults) × 2 (encoding conditions: self-reference vs. definition) repeated measures analysis of variance (ANOVA), performed on the hit rates for overall recognition, R and K responses.

3. RESULTS

The mean proportions and standard errors for Remember, Know responses and false alarms are presented in Figure 1. Because there was only one pool of lure items at recognition, the proportion of false alarms for each encoding condition was not available. Analysis of false alarms indicated no difference between young and older adults for overall recognition, $F(1, 38) = 2.77$, $p = .10$, $\eta^2_p = .07$, R responses, $F(1, 32) = 1.52$, $p = .23$, $\eta^2_p = .04$, or K responses, $F(1, 32) = 2.42$, $p = .13$, $\eta^2_p = .06$.

3.1. Overall Recognition

The ANOVA on overall recognition indicated an effect of age, $F(1, 38) = 4.08$, $p = .05$, $\eta^2_p = .09$ but no effect of encoding condition, $F(1, 38) = 1.49$, $p = .23$, $\eta^2_p = .04$, and no interaction between age and encoding condition, $F(1, 38) = .02$, $p = .88$, $\eta^2_p = .00$, (Definition encoding: young $M = .92$, $SD = .05$, and older adults $M = .86$, $SD = .14$; Self-reference encoding: young $M = .93$, $SD = .06$, and older adults $M = .88$, $SD = .13$).

3.2. Remember responses

The ANOVA on R responses showed no main effect of aging, $F(1, 38) = 1.89$, $p = .18$, $\eta^2_p = .05$, but revealed that participants had more Remember experiences for self-reference encoding than for definition encoding, $F(1, 38) = 25.83$, $p = .000$, $\eta^2_p = .40$. The interaction between age and encoding conditions was also significant, $F(1, 38) = 12.31$, $p = .001$, $\eta^2_p = .24$. Contrast analyses showed an age-related effect under the definition encoding condition, $F(1, 38) = 6.85$, $p = .01$, indicating that older adults gave fewer R responses. For the self-reference encoding condition, no such effect of aging appeared, $F(1, 38) = .02$, $p = .88$, with older adults giving as many R responses as younger adults.
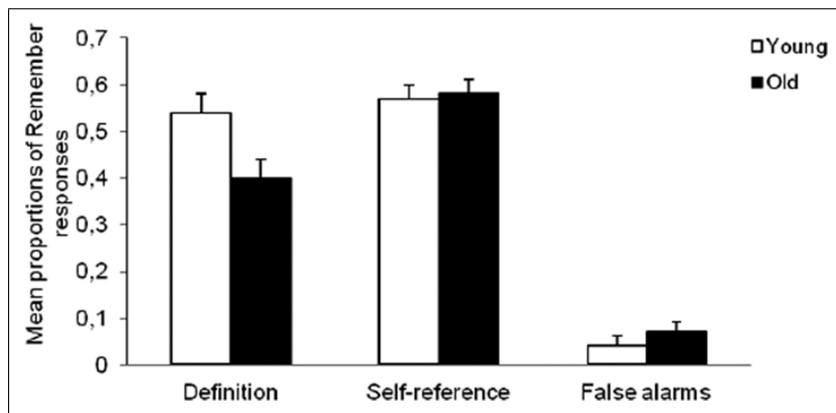
Figure 1a. Mean proportions and standard errors of Remember responses as a function of age (young versus older adults) and encoding condition (definition versus self-reference).
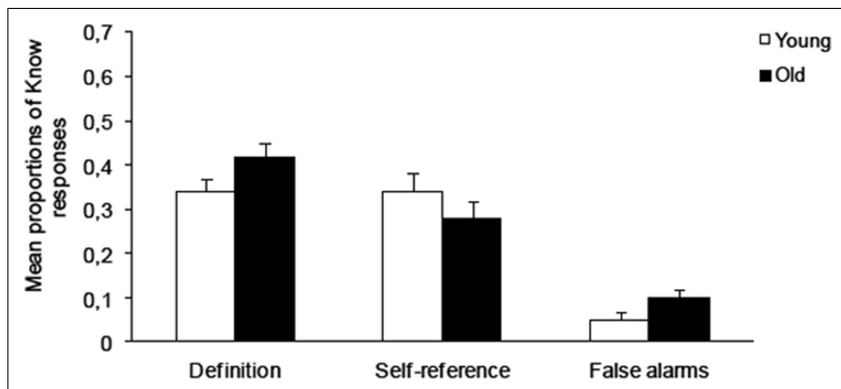
Figure 1b. Mean proportions and standard errors of Know responses as a function of age (young versus old adults) and encoding condition (definition versus self-reference).

3.3. Know responses

The analysis of K responses revealed no effect of age, $F(1, 38) = .01$, $p = .91$, $\eta^2_p = .00$, but indicated an effect of encoding condition, $F(1, 38) = 7,7$, $p = .008$, $\eta^2_p = .16$, with participants producing fewer Know experiences for self-referenced items. The interaction between age and encoding condition was significant, $F(1, 38) = 8,3$, $p = .006$, $\eta^2_p = .17$. Contrast analyses showed no difference between the definition and self-reference encoding conditions in the younger group, $F(1, 38) = .005$, $p = .94$. By contrast, the pattern of results for the older group revealed a difference between the two types of encoding task, $F(1, 38) = 16.00$; $p = .000$, with fewer K responses following self-reference encoding.

To summarize, self-reference encoding resulted in a greater number of Remember judgments in the older group, allowing them to compensate for their deficit in Remember judgments. Moreover, self-reference encoding had an effect on Know judgments, and more specifically in the older group who made fewer Know judgments when the item was encoded using self-reference.

4. DISCUSSION

The present study investigated age-related deficits in recollection, under different encoding conditions. Participants had to generate either a general definition of an adjective or a definition which referred to

themselves. Consistent with previous studies, the encoding task that required processing in terms of the self enhanced recollection of episodic details, compared to the other encoding task which did not involve the self (Conway et al., 2001; Van den Bos et al., 2010). For recognition without recollective experience, the pattern of results was the reverse, with fewer K responses following the self-reference task at encoding. Thus, it appears that self-reference encoding enhances the quality of the memory trace, but this was only apparent in the older group.

Our results are in line with other studies showing that older adults benefit from self-referential encoding to enhance recollection (Dulas et al., 2011; Hamami et al., 2011; Rosa & Gutchess, 2011). Most importantly, the age-related difference in recollective experience was eliminated under the self-reference encoding condition. Indeed, for R responses, we found an age-related deficit under the general definition condition, whereas when the older people processed information at encoding with reference to themselves, their remembering performance was comparable to that of the young adults. Moreover, the self-reference encoding condition induced an increase in R responses associated with a proportional decrease in K responses, which was most apparent in the older group. This observation suggests that self-reference enhanced the quality of the memory trace in the older group, with a shift in the phenomenological experience from noetic to autonoetic consciousness.

According to Rogers et al. (1977), the self functions as a "superordinate schema" to assist in the encoding, processing, interpretation, and retrieval of personal information. The advantage of self-referential processing could reflect access to a qualitatively different, well-developed structure—the self schema—which would allow extensive elaboration of stimuli and multiple routes for retrieval. According to this account, self-referential cognition benefits from the particularly elaborative nature of the self-construct, through which incoming information is easily encoded, organized, and enriched by stored autobiographical knowledge (Rogers et al., 1977; Symons & Johnston, 1997).

Surprisingly, no such benefit of self-referential processing was found for recollection in young participants, in contrast to the findings of numerous previous studies (Conway et al., 2001; Van den Bos et al., 2010). This null finding, associated with the evidence of the benefit of self-reference among older participants, is potentially of theoretical interest and could reinforce the view of the special mnemonic properties of self-referential encoding. First of all, it suggests that self-reference encoding is as efficient as a definition-generation encoding task which engages a high level of elaborative processing. Secondly, our results reveal a difference in

recollection between younger and older adults for the general definition encoding task but not for self-referential encoding. Our main hypothesis is that self-referential encoding engages qualitatively different processes than general definition encoding tasks which engage semantic processes. Indeed, studies on semantic encoding have shown that in some contexts older adults benefit from semantic encoding (i.e. generation encoding) to the same extent as young adults, but not sufficiently to compensate for age-related differences (Luo, Hendriks & Craik, 2007; Rabinowitz, 1989b), which could be explained by impaired semantic processing (Glisky & Marquine, 2009). In support of this hypothesis, a recent study by Sui and Humphreys (2013) challenges the view that the greater effectiveness of self-referential processing may be due to the fact that it is simply a strong form of semantic encoding (Greenwald & Banaji, 1989). In a case study of an amnesic patient suffering from semantic problems, they found that this patient presented a normal SRE on episodic memory, but that a semantic elaboration task had minimal effect on memory performance.

Further studies will be needed to determine whether self-referential encoding has specific properties, especially in older age, or whether it could be explained in terms of underlying memory mechanisms. A possible bias is the number of adjectives encoded: in our study participants only encoded 40, compared to 144 in the study of Gutchess et al. (2007).

In summary, this study provides optimistic evidence regarding the possibility of removing age-related differences in recollection by promoting enhanced self-reference encoding. Our experiment suggests that older adults benefit from associating information to be learned with their own experiences. The association of the R/K paradigm and self-reference seems to offer some interesting directions for future research.

REFERENCES

Bugaiska, A., Clarys, D., Jarry, C., Taconnat, L., Tapia, G., Vanneste, S., & Isingrini, M. (2007). The effect of aging in recollective experience: The processing speed and executive functioning hypothesis. *Consciousness and Cognition*, 16, 797–808.

Clarys, D., Bugaiska, A., Tapia, G., & Baudouin, A. (2009). Ageing, Remembering and executive function. *Memory*, 17, 158–168.

Content, A., Mousty, P., & Radeau, M. (1990). Brulex, une base de données

lexicalesinformatisée pour le français écrit et parlé. *L'Année Psychologique*, *90*, 551–566.

Conway, M. A. (2000). Phenomenological records and the self-memory system. In C. Hoeri, & T. McComack (Eds.), *Time and Memory: Issues in Philosophy and Psychology*. Oxford University Press: Oxford.

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.

Craik, F. I. M. (1986). A functional account of age difference in memory. In F. Flix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities, mechanisms and performances*. North Holland: Elsevier.

Craik, F. I. M. (1990). Changes with normal aging: A functional view. In R. J. Wutman (Ed.), *Advances in Neurology, 51: Alzheimer's disease*. Raven Press ltd: New-York.

Deltour, J. J. (1993). *Échelle de vocabulaire de Mill Hill de J. C. Raven. Adaptation française* et normes europeennes du Mill Hill et du Standard Progressive Matrices de *Raven (PM38)*. Braine-le-Chateau: Éditions l'application des techniques modernes.

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.

Folstein, M. F., Folstein, S. F., & McHugh, P. R. (1975). Mini-Mental State: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189–198.

Gardiner, J. M. (1988). Functional aspects of recollective experience. *Memory and Cognition*, *16*, 309–313.

Gardiner, J. M., Ramponi, C., & Richardson-Klavehn, A. (1999). Response deadline and subjective awareness in recognition memory. *Consciousness Cognition*, *8*, 484–496.

Genon, S., Bahri, M. A., Collette, F., Angel, L., D'Argembeau, A., Clarys, D., Kalenzaga, S., Salmon, E., & Bastin, C. (2013). Cognitive and neuroimaging evidence of impaired interaction between self and memory in Alzheimer's disease. *Cortex*. doi: 10.1016/j.cortex.2013.06.009.

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

Greenwald, A. G., & Banaji, M. R. (1989). The self as a memory system: Powerful, but ordinary. *Journal of Personality and Social Psychology*, *57*, 41–54.

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

Hamami, A., Serbun, S. J., & Gutchess, A. H. (2011). Self-referential processing and memory specificity with age. *Psychology & Aging*, *26*, 636–646.

Kalenzaga, S., Bugaiska, A., & Clarys, D. (2013). Self-reference effect and autonoetic consciousness in Alzheimer's disease: Evidence for a persistent affective Self in dementia patients. *Alzheimer Disease & Associated Disorders—An International Journal*, *27*, 116–122.

Luo, L., Hendriks, T., & Craik, F. I. M. (2007). Age differences in recollection: Three patterns of enhanced encoding. *Psychology and Aging*, *22*, 269–280.

Parkin, A. J., & Walter, B.M. (1992). Recollective experience, normal aging, and frontal dysfonction. *Psychology and Aging*, *7*, 290–298.

Perfect, T. J., Williams, R. B., & Anderton-Brown, C. (1995). Age differences in reported recollective experiences are due to encoding effects, note responses bias. *Memory*, *3*, 169–184.

Rabinowitz, J. C. (1989). Judgments of origin and generation effects: Comparisons

between young and elderly subjects. *Psychology and Aging, 4*, 259–268.

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.

Rosa, N. M., & Gutchess, A. H. (2011). Source memory for action in young and older adults: Self vs. close or unknown others. *Psychology & Aging*, *26*, 625–30.

Sui, J., & Humphreys, G. W. (2013). Self-referential processing is distinct from semantic elaboration: Evidence from long-term memory effects in a patient with amnesia and semantic impairments. *Neuropsychologia*, *51*, 2663–73.

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

Tulving, E. (1985). Memory and consciousness. *Canadian Psychologist*, *26*, 1–12.

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

Wheeler, M. A., Stuss, D. T., & Tulving, E. (1997). Toward a theory of episodic memory: The frontal lobes and autonoetic consciousness. *Psychological Bulletin*, *121*, 331–354.

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.