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The role of self-referencing in true and false recognition in young people and healthy older people

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Abstract

Background: Given the uneven results about the role self-referencing plays in false recognition, we planned an experiment that would allow us to analyze whether self-referencing affects false recognition, and its relationship with healthy aging. **Method:** A sample of healthy older people (n = 30) and another sample of young people (n = 38) rated whether 40 personality-trait adjectives (20 with a positive valence and 20 with a negative valence) described them or not (self-referencing condition). They then took a recognition test of these adjectives along with 40 other new adjectives. Next, they rated whether 40 other different adjectives described a third person or not (other-referencing condition), and then performed another similar recognition test. These two conditions were counter-balanced across participants. **Results:** The results clearly showed that self-referencing produces both an increase in true recognition and a decrease in false recognition in both samples. **Conclusions:** Our results support the idea that self-referencing reduces false recognition by using conscious monitoring strategies, and that self-referencing is a suitable cognitive method for enhancing older individuals' impaired memory.

Keywords: aging; memory, self-reference effect, true recognition, false recognition.

Resumen

El papel del efecto de auto-referencia sobre el verdadero y falso reconocimiento en jóvenes y mayores sanos. **Antecedentes:** dados los resultados contradictorios acerca del papel que el efecto de auto-referencia ejerce sobre el falso reconocimiento, diseñamos un experimento para analizar si dicho efecto afecta al falso reconocimiento y su relación con el envejecimiento. **Método:** una muestra de personas mayores sanas (n = 30) y otra muestra de personas jóvenes (n = 38) valoraron si 40 adjetivos sobre rasgos de personalidad (20 de ellos con valencia positiva y 20 con valencia negativa) los describían o no (condición de auto-referencia). A continuación llevaron a cabo una tarea de reconocimiento sobre dichos 40 adjetivos junto con otras 40 adjetivos nuevos. Después valoraron otros 40 adjetivos en relación a una tercera persona (condición de otra-referencia), seguida de su correspondiente test de reconocimiento. Estas dos condiciones se contrabalanceron entre participantes. **Resultados:** los resultados mostraron claramente que la condición de autoreferencia produce tanto un incremento en el reconocimiento correcto como un decremento en el falso reconocimiento en ambas muestras. **Conclusiones:** nuestros resultados apoyan la idea de que el efecto de autoreferencia reduce el falso reconocimiento mediante el uso de estrategias conscientes de monitorización, y que el método de autoreferenciar es una estrategia cognitiva eficiente para mejorar la memoria de las personas mayores.

Palabras clave: envejecimiento, memoria, efecto de auto-referencia, reconocimiento correcto, falso reconocimiento.

It is well known that we recall and recognize stimuli that have been encoded as relevant for oneself (*self-referencing*) better than those that have been encoded as not related to oneself (*other-referencing*: e.g. related to a third person). This enhanced memory for self-referenced information is known as the *self-reference effect* (SRE; Rogers, Kuiper, & Kirker, 1977). This effect has received a large amount of experimental support (e.g., Symons & Johnson, 1997), and it is robust across encoding tasks (e.g., incidental or intentional learning; Gutchess, Kensinger, Yoon, & Schacter, 2007), testing tasks (e.g., recall or recognition; Lalanne, Rozenberg, Grolleau, & Piolino, 2013), and materials (traits, nouns, objects, actions, etc.; Rosa & Gutchess, 2011). This SRE has also been elicited in early childhood (Cunningham, Brebner, Quinn, & Turk, 2014) and in healthy older people (Gutchess et al., 2007), which shows that the self-concept is relatively stable throughout the lifespan (Conway, 2005; Hamami, Serbun, & Gutchess, 2011). The SRE is reflected in recollective judgments (that is, conscious judgments that elicit contextual information), but not in familiarity judgments (in which information is recovered automatically, without eliciting contextual traces; Conway & Dewhurst, 1995). Several studies show the importance of attentional resources at encoding in the SRE, because this effect disappears under divided-attention conditions (Turk et al., 2013). Self-reference judgments seem to enable deeper processing (Craik & Lockhart, 1972), integrate different processing stages (e.g. linking attention to memory and decision making; Sui & Humphreys, 2015), increase emotional or affective arousal (Leblond et al., 2016), or evoke a

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schematic autobiographical prototype of oneself (Conway, 2005). This process leads to memories that are more likely to be retrieved than memories encoded with any other reference (see Klein, 2012; Sui & Humphreys, 2015, for recent reviews of this multifaceted entity). Moreover functional neuroimaging evidence suggests that the self engages a unique neuroanatomical substrate located in the ventromedial prefrontal cortex (Yaoi, Osaka, & Osaka, 2015).

Self-referencing can be an advantageous mnemonic strategy for older adults. For example, many studies have shown that older people, compared to young people, have an associative deficit for binding pieces of information (see meta-analysis by Old & Naveh-Benjamin, 2008). Nevertheless, older people are capable of showing greater recognition for self-referenced items (and even specific details about them) than for other-referenced items (Hamami et al., 2011). However, this benefit is smaller than the one observed in young people (Gutchess et al., 2007), which shows that self-referencing increases binding between stimuli (acting as a "glue"; Sui & Humphreys, 2015). Therefore, self-referencing could be used as a cognitive strategy for enhancing older individuals' mnemonic capacity. However, the results on SRE in populations of older people with mild cognitive impairment (MCI) or Alzheimer's Disease (AD) are less consistent, from studies that endorse the role of facilitating self-referencing (Kalenzaga, Bugaïska, & Clarys, 2013; Lalanne et al., 2013; Rosa, Deason, Budson, & Gutchess, 2014) to studies where this effect has not been elicited (Genon et al., 2014; Leblond et al., 2016; Rosa, Deason, Budson, & Gutchess, 2015).

However, relating information to oneself can also affect false memories. It is well known that false recognition and false memories increase with age (Schacter, Koutstaal, & Norman, 1997), which has been explained in the literature mainly by two theoretical models. On the one hand, the "fuzzy trace" theory (Reyna & Brainerd, 1995) emphasizes the fact that old people, due to their limited capacity to recollect item-specific information, tend to trust their retrieval judgments in their *gist* memory (or the general theme of the information underlying the stimuli studied), producing an increase in their true recognition as well as in their false recognition. On the other hand, the activation-monitoring theory (Roediger, Watson, McDermott, & Gallo, 2001) establishes that during the study task, not only are the studied items activated, but also the items semantically related to them, due to the spreading activation from one to the other. At the time of retrieval, the subject carries out a conscious monitoring process to distinguish between studied and non-studied items. Given that the lure items can be highly activated because they are related to the studied items, source-monitoring errors can occur (Johnson, Hashtroudi, & Lindsay, 1993), giving rise to false recognition or false memory. However, as young adults have a well-preserved ability to recollect item-specific information, they can use it to reduce their false alarm rates by using conscious monitoring strategies such as "recall-to-reject" (Brainerd, Reyna, Wright, & Mojardin, 2003). This strategy involves rejecting a non-studied lure because the participant can consciously recollect some instantiating targets (e.g. "I remember that I studied items A, B, C associated with myself, but not item D"). Thus, these conscious monitoring strategies show that inferential processes are an essential part of the acts of remembering and recognizing (Johnson et al., 1993). Many studies have found support for the correct use of these monitoring strategies in young people, but less in healthy older people or older people with cognitive impairment, due to their aforementioned recollection deficits (Pitarque et al., 2016).

However, few studies have analyzed the relationships among SRE, false memory, and aging, and they have shown inconclusive results. For example, Rogers, Rogers, & Kuiper (1979) found that young adults' false recognition increased as the information was more self-descriptive. Along the same lines, both Gutchess et al. (2007) and Rosa and Gutchess (2013), comparing a sample of young people and another sample of healthy elderly people, also found that self-referencing increased the rates of both hits and false alarms in both samples (and especially in the elderly people). This result was explained in the sense that information related to the self is processed more deeply (Craik & Lockhart, 1972), creating a feeling of familiarity that increases both true and false recognition (that is, giving rise to a more liberal response bias), especially in elderly adults because they are more prone to false memories than young people (Schacter et al., 1997). Nevertheless, Rosa et al. (2015), comparing a sample of healthy elderly people to a sample of MCI patients, found the expected SRE only in healthy elderly participants. They found no difference in false alarms between the self and control conditions in the two samples, indicating that self-reference does not necessarily lead to an increase in false recognition in healthy aging, contradicting their previous results (Gutchess et al., 2007; Rosa & Gutchess, 2013). Similar results can be found in Leblond et al. (2016), who, when comparing three samples of elderly people (healthy older people, MCI and AD patients), found significant differences in their hit rates, but not in their false alarm rates, which would seem to indicate that SRE does not affect false recognition.

Given these contradictory results about the role played by SRE in false recognition and healthy aging, we planned an experiment following the conventional procedure for the SRE paradigm (e.g., Gutchess et al., 2007) to analyze whether self-referencing affects false recognition, and its relationship with healthy aging, by comparing a sample of young adults and another sample of healthy older people. We hypothesize that if self-referencing enables deeper processing (Craik & Lockhart, 1972) than other-referencing, it will increase the familiarity of the studied items as well as the non-studied but related items, leading to an increase in both true and false recognition (especially in older people in the latter case), and giving rise to a more liberal response bias (Rosa & Gutchess, 2013). Similar predictions would be expected if the self-referencing condition could give rise to a *gist* memory configured by these self-descriptive personality traits, both the ones that were really studied and those that were not. This would produce an increase in true and false recognition, and especially in elderly people because, even though they have an impairment in specific-item information, their gist memory is preserved (Reyna & Brainerd, 1995). By contrast, only if we assume that self-referencing not only increases the familiarity of the studied items and the items related to them (making them both more accessible to recognition), but also improves some inferential monitoring strategies (such as recall-to-reject), an increase in the hit rates would be expected, as well as a reduction in false alarm rates. Furthermore, this reduction should be greater in young people than in older people, due to the lower recollective capacity of the latter.

Method

Participants

Participants consisted of 38 young adults (undergraduates at the University of Valencia; 11 men, 27 women, mean age = 22.39

years, *SD* = 2.42) and 30 older adults (recruited from several centers for elderly people from the city of Valencia; 13 men, 17 women, mean age = 72.77 years, *SD* = 7.63). All participants reported being in good physical and mental health. In this regard, the mean on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975; Lobo, Saz, & Marcos, 2002, for the Spanish version) for the older adults was 27.87 (*SD* = 1.48), thus showing no memory impairment. The two groups were matched on gender ($\chi^2 = 1.52$) and vocabulary (Wechsler Adult Intelligence Scale, WAIS-III; Wechsler, 2001; $t(66) < 1$), but differed on education level with young people having a higher educational level than older people ($t(66) = 7.95$, $p < .001$; e.g. Lalanne et al., 2013).

Instruments

Participants first responded to a short socio-demographic questionnaire. Then older participants responded to the MMSE (Lobo et al., 2002) as a screening test for possible cognitive impairment, establishing a score below 23 as the cut-off for exclusion from the study (no participant was excluded). Finally, all participants completed the vocabulary subtest of the WAIS-III (Wechsler, 2001) as a way to analyse their premorbid intelligence level.

Materials came from a Spanish translation of Anderson's (1968) personality traits inventory (as e.g. in Lalanne et al., 2013, for French materials). From this adjective base, 80 adjectives were selected with a positive valence (*M* = 482.95, range from 573 to 427) and 80 adjectives with a negative valence (*M* = 113.88, range from 196 to 37). Both lists were balanced on meaningfulness (means of 358.9 and 360.68, respectively) and number of letters (means of 8.30 and 8.61 respectively). For each participant, four blocks of 20 adjectives with a positive valence and four blocks of 20 adjective with a negative valence were randomly selected. These adjectives were used as study and recognition lists for the self-referencing and other-referencing conditions.

Procedure

Each participant performed four tasks in a sequential order, study and test related to the self-referencing condition and study and test related to the other-referencing condition (in this case, the current Spanish king, Felipe VI; see e.g. Kalenzaga & Clarys, 2013), with both conditions counterbalanced between subjects. On the first task, the subjects had to rate whether 40 adjectives (20 with a positive valence and 20 with a negative valence, presented in sequential and random order) described the participant or not (self-reference condition; e.g. *Would you consider yourself to be a friendly person?*), using the S or N keys to respond (as yes or no, respectively). The adjectives were presented for 6 seconds (Rosa & Gutchess, 2013). Next, and after a 10-minute distraction task (easy arithmetic operations), the participants performed a recognition task (self-paced) of the 40 previous adjectives randomly intermingled with 40 other new adjectives (20 with a positive valence and 20 with a negative valance), presented in sequential and random order. To answer, they used the S or N keys (for yes or no, respectively). After another 10-minute distraction task, the participants performed two (study and test) tasks similar to the previous ones, but related to the other-reference condition (the current king of Spain in this case; e.g. *Do you think Felipe VI is an unhappy person?*). The order of the self-referencing and other-referencing conditions was counterbalanced.

Data analysis

The data were analyzed by means of mixed factorial analysis of variance (ANOVA) with groups as the between-subject variable (young/older people) and references (self/other reference) as the within-subject variable. The significance level for all statistical tests was $p \leq 0.05$.

Results

A1. Corrected recognition

Individual corrected recognition scores were calculated by subtracting the proportion of false alarms (FA) from the proportion of hits (H; see Table 1) to test whether there was a difference in memory accuracy across groups as an effect of self-reference. To test this, a mixed ANOVA of 2 groups X 2 references indicated a significant main effect of both groups and references ($F(1, 66) = 53.27$, $p<.001$, $\eta^2_p = .45$; $F(1, 66) = 31.95$, $p<.001$, $\eta^2_p=.33$, respectively). Young participants demonstrated better memory (*M* = 0.59) than older people (*M* = 0.34), and self-referencing led to better memory (*M* = 0.53) than other-referencing (*M* = 0.40), confirming the SRE (Symons & Johnson, 1997) and supporting our experimental procedure. The interaction was not significant ($F(1, 66) < 1$), indicating that both young people and older people showed better recognition of self-referenced stimuli than other-referenced (means of 0.65 and 0.53 for the young people, and 0.40 and 0.28 for the older people, respectively), coinciding with other studies (Gutchess et al., 2007; Hamami et al., 2011; Rosa & Gutchess, 2013). Thus, the findings suggest that self-referencing provides an age-equivalent boost in memory. Logically, the older people start from a lower basal level than the young people because aging entails both a binding deficit during encoding (Old & Naveh-Benjamin, 2008) and a recollection impairment during retrieval (Koen & Yonelinas, 2014). However, self-referencing partially compensates for these deficits, increasing the binding between the stimuli and the self (Sui & Humphreys, 2015). Therefore, our results show that it could be used as a mnemonic strategy for enhancing older individuals' impaired memory (Hamami et al., 2011).

Corrected recognition was also calculated by individual discrimination indexes (*d'*; Table 1). To calculate these *d'* scores (and also the response bias indexes; see below), hit rates and FA

Table 1
Mean proportions (and SE) of hits, false alarms, corrected recognition, discrimination indexes and response bias of young and healthy older people for Self-referencing and Other-referencing conditions

	Young		Older people	
	Self	**Other**	**Self**	**Other**
Hits (H)	0.88 (0.02)	0.83 (0.02)	0.76 (0.02)	0.67 (0.03)
False Alarms (FA)	0.24 (0.03)	0.30 (0.03)	0.36 (0.03)	0.39 (0.03)
Corrected recognition (H - FA)	0.65 (0.03)	0.53 (0.03)	0.40 (0.03)	0.28 (0.02)
Discrimination index *(d')*	2.12 (0.10)	1.63 (0.08)	1.22 (0.11)	0.81 (0.09)
Response bias *(C* values)	-0.25 (0.07)	-0.24 (0.07)	-0.22 (0.08)	-0.11 (0.08)

rates of 0 and 1 were converted to 0.02 and 0.98, respectively, to avoid infinitely large *d'* values (Cohn, Emrich, & Moscovitch 2008). The mixed ANOVA on these *d'* exactly mimicked the results found on H-FA; that is, the main effects of both groups and references were shown to be significant ($F(1, 66) = 60.49$, $p<.001$, $\eta^2_p = .48$; $F(1, 66) = 34.51$, $p < .001$, $\eta^2_p=.34$, respectively). The interaction was not significant ($F(1, 66) < 1$).

A2. Hits

The mixed ANOVA of 2 groups X 2 references on hits (Table 1) showed significant main effects of the two variables, groups ($F(1, 66) = 24.55$, $p<.001$, $\eta^2_p = .27$, indicating that young people had more hits than elderly people; means = 0.86 and 0.72, respectively), and references ($F(1, 66) = 17.07$, $p<.001$, $\eta^2_p = .21$, indicating that self-referencing led to more hits than other-referencing; means = 0.82 and 0.75, respectively). The interaction was not significant ($F(1, 66) < 1$), indicating that both young and older people had more hits on self-referenced stimuli than on other-referenced stimuli (means of 0.88 and 0.83 for young people, and 0.76 and 0.67 for older people, respectively). These results again show a significant SRE and the well-known deficit in the recognition capacity of older people, compensated partially by the facilitator role of the self-referencing condition.

A3. False alarms

The mixed ANOVA of 2 groups X 2 references on false alarms (FA; Table 1) showed significant main effects of the two variables, groups ($F(1, 66) = 7.77$, $p<.01$, $\eta^2_p = .11$, indicating that elderly people committed more FA than young people; means = 0.37 and 0.27, respectively) and references ($F(1, 66) = 8.66$, $p<.01$, $\eta^2_p = .12$, indicating that self-referencing led to fewer FA than other-referencing; means = 0.30 and 0.35, respectively). The interaction was not significant ($F(1, 66) < 1$), indicating that both young and older people committed fewer FA on self-referenced stimuli than on other-referenced stimuli (means of 0.24 and 0.30 for young people, and 0.36 and 0.39 for older people, respectively). These results show that older people committed more FA than young people, as shown in the literature on false recognition and false memory (Schacter et al., 1997), but self-referencing plays a protector role against false recognition in both young and older people. This result invalidates different explanations of the role that self-referencing plays in false recognition, either in terms of a mere increase in the activation of the items related to the studied items (Rosa & Gutchess, 2013), or responding based on a *gist* memory configured by these self-descriptive personality traits (both the studied items and those related to them). If these explanations were correct, in both cases an increase in FA would be expected in the self-referencing condition, which should also be evident in a more lenient response bias in this condition (which does not occur; see next paragraph). By contrast, the reduction in FA found in the self-referencing condition would have to be explained in terms of self-referencing improving the correct use of inferential monitoring strategies (such as recall-to-reject) by both young and older people to reduce their FA rate. This explanation emphasizes the idea that self-referencing is a suitable conscious cognitive strategy for enhancing older individuals' impaired memory because it leads to both an increase in true recognition and a decrease in false recognition.

A4. Response bias

C values were calculated for each participant as a way to assess his/her response bias. Negative *C* values indicate a liberal or lenient bias (that is, saying "yes" on recognition), whereas positive *C* values indicate a conservative bias (that is, saying "no" on recognition). A mixed ANOVA of 2 groups X 2 references on *C* values (Table 1) showed non-significant main effects of the two variables ($F(1, 66) < 1$; $F(1, 66) = 1.75$, respectively) and their interaction ($F(1, 66) = 1.09$). These results, coinciding with those for FA, again invalidate explanations of the role that self-referencing plays in false recognition in terms of a mere increase in the activation or familiarity of the items related to the studied items (Rosa & Gutchess, 2013), or in terms of responding based on a *gist* memory of self-descriptive personality traits.

Discussion

Our results clearly show that self-referencing produces an increase in true recognition and a decrease in false recognition in both young and older people, showing that the SRE remains intact with age (Conway, 2005; Hamami et al., 2011).

The increase in true recognition produced by the SRE is significantly greater than its effect on the decrease in false recognition (effect sizes = 0.33 and 0.12, respectively). In other words, the SRE is less evident in false recognition than in true recognition, and this may be the reason that some studies have found null results for the role this effect plays in false recognition (e.g., Leblond et al., 2016; Rosa et al., 2015).

In our study, we have shown that self-referencing plays a minor but significant protective role against false recognition in both young and older people. This would be difficult to explain based exclusively on the understanding of the SRE only in terms of automatic activation of the studied items and the items related to them, or in terms of responding based on a *gist* memory of self-descriptive personality traits. By contrast, our results seem to support the idea that SRE also improves the correct use of inferential monitoring strategies (Roediger et al., 2001), such as recall-to-accept (to increase hits) or recall-to-reject (to decrease FA), in both young and older people. Given that older people show associative deficits compared to younger people (Old & Naveh-Benjamin, 2008), their baseline level is lower than that of young people, and so their overall results are worse. However, the improvement in hits produced by the SRE and the reduction in FA are constant across the two samples, which would support the idea that self-referencing is a suitable conscious cognitive strategy for enhancing older individuals' impaired memory.

As Kalenzaga and Clarys (2013) point out, it seems that there are two ways to process self-referential knowledge in human cognition: one is implicit (based on the automatic activation of the studied items), and the other is explicit (based on the use of inferential monitoring strategies), as the dual activation-monitoring theory proposes (Roediger et al., 2001). Our sample of older people was composed of cognitively healthy people who probably had, to some extent, a well-preserved capacity for explicit processing. If the explanation we have offered for our results is correct, then the SRE benefits observed here (especially regarding the reduction in false recognition) would be expected to disappear in our MCI or AD patients, patients who should appeal to mainly implicit

processing of information, given their well-known recollective deficits. Results like those of Genon et al. (2014), Leblond et al. (2016), or Rosa et al. (2015) point in this direction, but further research is needed in this line of research.

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