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Short title: who am I?

**Autobiographical recall as a tool to enhance the sense of self in Alzheimer's disease**

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### **Conflict of interests**

The authors declare no conflict of interests

We investigated whether autobiographical retrieval would improve the sense of self in Alzheimer's disease (AD). Participants with AD and controls were asked to produce statements describing their self, i.e., statements to the question "Who am I?", after two conditions: after autobiographical retrieval and after a control verbal fluency task. The production of "Who am I?" statements was analyzed regarding three self-dimensions (i.e., physical self, social self, and psychological self). Results revealed better production of descriptions related to physical self, social self, and psychological self after autobiographical retrieval than after the control condition in AD patients and control participants. At a clinical level, encouraging patients to retrieve autobiographical memories may be used as a tool to activate the sense of self in AD. At a theoretical level, they are concordant with a model suggesting a bidirectional relationship between autobiographical memory and the self in AD.

*Key words:* Alzheimer's disease; autobiographical memory; identity; physical self, social self; psychological self

## 1. Introduction

Alzheimer's disease (AD) is a neurodegenerative disorder characterized at the neuropathological level by an abnormal assembly of the amyloid  $\beta$ -protein (Musiek & Holtzman, 2015). At the cognitive level, AD is mainly characterized by profound memory loss that interferes with social and occupational functioning (El Haj, Antoine, et al., 2016; McKhann et al., 2011). AD has been found to compromise autobiographical memory, i.e., memory for personal information (El Haj, Antoine, Nandrino, & Kapogiannis, 2015; El Haj, Roche, Gallouj, & Gandolphe, 2017). Generally speaking, autobiographical memory encompasses two main components : a semantic one and an episodic one (Conway, 2005; Rubin, 2005). The semantic component refers to generic knowledge that covers lifetime periods (e.g., “when I was young”) and repeated events (e.g., “I used to walk to the school every day”). In contrast, the episodic component refers to specific memories that occurred at a particular time and place (e.g., “one day I arrived late at school”). Unlike semantic memories, episodic autobiographical memories trigger a state of auto-noetic consciousness by which the phenomenological subjective experience of the past is relived thanks to mental time travel (Tulving, 2002).

A major characteristic of autobiographical memory compromise in AD is overgenerality, i.e., the reduced ability to produce specific personal events (Barnabe, Whitehead, Pilon, Arsenault-Lapierre, & Chertkow, 2012; De Simone et al., 2016; El Haj, Antoine, Nandrino, Gely-Nargeot, & Raffard, 2015; El Haj, Fasotti, & Allain, 2012; El Haj, Postal, Le Gall, & Allain, 2011; Graham & Hodges, 1997; Greene, Hodges, & Baddeley, 1995; Irish, Lawlor, O'Mara, & Coen, 2011; Ivanoiu, Cooper, Shanks, & Venneri, 2006; Kirk & Berntsen, 2017; Leyhe, Muller, Milian, Eschweiler, & Saur, 2009; Martinelli, Anssens, Sperduti, & Piolino, 2013; Muller et al., 2013; Seidl, Lueken, Thomann, Geider, & Schroder, 2011). Overgenerality is thought to result in a diminished ability to mentally relive past events

and a general feeling of knowing or familiarity that may be expressed by AD patients as a sense of “having experienced this before”. (El Haj, Kapogiannis, & Antoine, 2016; El Haj, Moroni, Samson, Fasotti, & Allain, 2013; Hudon, Belleville, & Gauthier, 2009; Piolino et al., 2003; Rauchs et al., 2007). The decreased ability to retrieve specific memories has also been related with disruption of the sense of self (Mograbi, Brown, & Morris, 2009; Morris & Mograbi, 2013). According to the AMAD model (Autobiographical Memory in Alzheimer’s Disease) (El Haj, Antoine, Nandrino, & Kapogiannis, 2015), owing to autobiographical generality as well as anterograde amnesia (i.e., inability to form new memories) and retrograde amnesia (i.e., inability to retrieve old memories), AD patients have limited access to memories that shape their self-knowledge, self-consciousness and self-image, resulting in a disruption of the of identity. The disruption of identity in AD can also be illustrated by studies suggesting difficulties with self-recognition in advanced AD (Caddell & Clare, 2010), as well as by studies demonstrating that patients with advanced AD may have difficulty in recognizing themselves in the mirror (Biringer & Anderson, 1992; Biringer, Anderson, & Strubel, 1988; Grewal, 1994). The relationship between the disruption of the sense of self and autobiographical compromise in AD was emphasized by Klein et al. (2003) who asked a patient to rate her personality now and before the onset of dementia. The authors found that the patient's ratings reflected memories about old self-images. These findings reflect the assumption that general self-knowledge in AD may be intact, thanks to semantic autobiographical memories, but outdated (S. B. Klein, Cosmides, & Costabile, 2003; S. B. Klein & Lax, 2010; Morris & Mograbi, 2013).

The relationship between the compromise of autobiographical memory and the disruption of the sense of self in AD was assessed by Addis and Tippett (2004) who asked mild AD patients to retrieve autobiographical events and to perform two identity tests : the Tennessee Self-Concept Scale (Fitts & Roid, 1964) and the Twenty Statements Test (Kuhn &

McPartland, 1954). On the Tennessee Self-Concept Scale, patients had to rate statements describing physical characteristics (e.g., “I have a healthy body”), personality (e.g., I’m a cheerful person), family roles (e.g., “I am a grandmother”), social characteristics (e.g., “I’m a friendly person”), as well as morals valued (e.g., “I am a decent person”). On the Twenty Statements Test, they had to provide 20 statements to the question “Who am I?”. The study by Addis and Tippett (2004) revealed a decreased sense of identity in AD patients, a decline that was significantly correlated with autobiographical performance. Building on the results of Addis and Tippett (2004), a recent study assessed whether retrieval of information related to the self would influence autobiographical memory in AD (El Haj & Antoine, 2017). To this end, patients with mild AD were asked to retrieve autobiographical memories after providing statements to the question “Who am I?”, as well as after a control condition consisting of reading a general text. AD patients showed better autobiographical recall after the “Who am I?” statements than after reading the text. These findings suggest that retrieval of information related to the self may have a positive effect on autobiographical recall in AD.

Considering the positive effect of retrieval of self-related information on autobiographical memory in AD, the present study investigated whether autobiographical recall in AD may enhance retrieval of self-related information. This issue was investigated by Charlesworth, Allen, Havelka, and Moulin (2015) who asked young participants to retrieve autobiographical memories or to write a description of the solar system in a control condition; both the autobiographical retrieval and control condition were followed by “Who am I?” statements. Results demonstrated higher production of “Who am I?” statements after autobiographical retrieval than after the control condition. These findings suggest that autobiographical retrieval enhances access to self-related information in younger adults. Our study tested these findings in AD. We tested the production of “Who am I?” statements after autobiographical retrieval, as well as after a control verbal fluency task. To further probe the

effect of autobiographical retrieval on the sense of self, we analyzed “Who am I?” statements regarding three self-dimensions, i.e., physical self, social self, and psychological self. These categories, based on the initial description by William James (1892), were proposed by Charlesworth et al. (2015) who defined physical self as knowledge about attributes that are related to one’s own appearance (e.g., I am fat, I am tall, I am bald,), social self as knowledge about one’s own social category (e.g., I am a psychologist, I am a researcher, I am French), and psychological self as knowledge about one’s own personality trait (e.g., I am decent, I am kind, I am helpful).

There is a body of evidence suggesting an intimate relationship between the sense of self and autobiographical retrieval in AD (Addis & Tippett, 2004; El Haj, Antoine, & Kapogiannis, 2015b; El Haj, Antoine, Nandrino, & Kapogiannis, 2015; S. B. Klein et al., 2003; S. B. Klein & Lax, 2010; Martinelli et al., 2013; Mograbi & Morris, 2013; Morris & Mograbi, 2013). Our previous research has demonstrated that retrieval of self-related information may enhance autobiographical retrieval in AD (El Haj & Antoine, 2017). Building on our previous findings, this study investigated whether autobiographical retrieval may enhance access to self-related information in AD. We further assessed whether autobiographical retrieval may influence a particular self-dimension (i.e., physical self, social self, or psychological self). Our study was motivated by clinical and theoretical needs. At a clinical level, it would be useful to have a cognitive tool available (here, encouraging patients to retrieve autobiographical memories) that enhances the sense of self in AD. At a theoretical level, it would be of interest to reveal any bidirectional relationship between autobiographical memory and the self in AD, because previous research has demonstrated the effect of retrieval of self-related information on autobiographical memory in AD (El Haj & Antoine, 2017). If any reverse effect were to be found, it would provide the empirical basis for a model suggesting a bidirectional relationship between autobiographical memory and the self in AD.

## 2. Method

### 2.1. Participants

The study included 28 participants with a clinical diagnosis of probable mild AD (19 women and 9 men;  $M$  age = 71.14 years,  $SD$  = 4.56;  $M$  years of formal education = 8.79,  $SD$  = 2.31) and 31 control older adults (20 women and 11 men;  $M$  age = 68.42 years,  $SD$  = 7.67;  $M$  years of formal education = 9.55,  $SD$  = 2.68). The AD participants were recruited from local retirement homes and were diagnosed with probable AD dementia of the amnesic form by an experienced neurologist or geriatrician based on the National Institute on Aging-Alzheimer's Association clinical criteria (McKhann et al., 2011). The fact that all patients had the amnesic form of AD was confirmed by their performance on the neuropsychological battery. The control participants, who were often spouses or companions of AD patients, were independent and living at home. These participants were matched with the AD patients according to age [ $t(57) = 1.64, p > .10$ ], sex [ $X^2(1, N = 59) = .07, p > .10$ ], and educational level [ $t(57) = 1.16, p > .10$ ].

Exclusion criteria for all participants were as follows: significant psychiatric or neurological illness, alcohol or drug use, or history of clinical depression. No participants presented any major visual or auditory acuity difficulties that would have prevented completion of the study tasks. They freely consented to participate and were free to withdraw whenever they wished. The study was approved by the ethical board of the University of Lille3.

#### 2.1.1. Cognitive characteristics

Cognitive characteristics of all participants, summarized in Table 1, were evaluated with a battery tapping general cognitive functioning, episodic memory, spans, verbal fluency and depression. General cognitive functioning was assessed with the Mini Mental State Exam (MMSE) (Folstein, Folstein, & McHugh, 1975). Verbal episodic memory was evaluated with a French adaptation (Van der Linden et al., 2004) of the task of Grober and Buschke (1987). The participants had to retain 16 words, each of which describes an item that belongs to a different semantic category. After immediate cued recall, the participants proceeded to a distraction phase, during which they had to count backwards from 374 in serial 20 s. This phase was followed by two minutes of free recall and the score from this phase (out of a maximum of 16) provided a measure of episodic memory. In the span assessment, participants had to repeat a string of single digits in the same order (i.e., forward span) or in the reverse order (i.e., backward span). Verbal fluency was assessed with a task on which participants had two minutes to generate as many words as they could beginning with the letter P. Proper nouns and variations on words (e.g., “psychology” and “psychologist”) were not allowed. The score was the number of correctly generated words. To assess depression, the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983) was administered. This self-report scale consists of seven items on a four-point scale from 0 (not present) to 3 (considerable). As recommended by Herrmann (1997), the cut-off for definite depression was set at > 10/21 points.

Table 1

*Cognitive characteristics of Alzheimer's disease (AD) patients and control participants*

Task		AD <i>n</i> = 28	Older adults <i>n</i> = 31
<b>General Cognitive functioning</b>	Mini-Mental State Examination (MMSE)	21.50 (1.86)***	28.00 (1.55)
<b>Verbal memory</b>	Grober and Buschke	5.96 (2.35)***	11.03 (3.05)
<b>Span</b>	Forward span	5.03 (1.08)***	6.56 (1.64)
	Backward span	3.64 (1.19)**	4.65 (1.58)
<b>Verbal fluency</b>	Letter "P"	17.04 (5.58)***	22.84 (5.17)
<b>Depression</b>	HADS	8.29 (1.49)**	6.84 (2.08)

*Note.* Standard deviations are given between brackets; the maximum score on the MMSE was 30 points; the maximum score on the Grober and Buschke (1987) task was 16 points; performances on the forward and backward spans refer to the number of correctly repeated digits; the fluency score was the number of correctly generated words; the cut-off on the HADS (Hospital Anxiety and Depression Scale) was > 10/2 points; differences between groups were significant at: \*\* $p < .01$ , \*\*\* $p < .001$ ; after checking for normality of distributions, comparison for the MMSE and forward span was established with Mann-Whitney's U test (abnormal distribution) and comparisons for remaining tasks were established with Student's t-test (normal distribution).

## 2.2. Procedures

The participants were assessed on two occasions, counterbalanced and spaced five to seven days apart. In one condition, the “Who am I?” task, assessing the sense of self, was administered after autobiographical retrieval; in the other condition, the “Who am I?” task was administered after the verbal fluency task. The latter was chosen as a control task because, like autobiographical retrieval, both tasks require verbal memory.

### 2.2.1. Autobiographical memory

Autobiographical recall was assessed with the following instruction: “recount in detail an event in your life”, a simple instruction that is widely used to cue autobiographical memory in individuals with AD (Fromholt & Larsen, 1991). Participants were allocated two minutes to describe their memories, and the duration was made clear to them so that they could structure them accordingly. This time limit was adopted to avoid redundancy or distractibility and was found to be sufficient for autobiographical recollection in individuals with AD (El Haj, Antoine, & Kapogiannis, 2015a, 2015b; El Haj et al., 2012).

Autobiographical performance was analyzed with respect to specificity assessed with the TEMPau scale (Test épisodique de mémoire du passé (Piolino, Desgranges, Benali, & Eustache, 2002)), an instrument derived from classic autobiographical evaluations (Kopelman, 1994) and adapted in French. For each event, we attributed zero if there was no memory or only general information about a theme, one point for a repeated or an extended event, two points for an event situated in time and/or space, three points for a specific event lasting less than 24 h and situated in time and space, and four points for a specific event situated in time and space enriched with phenomenological details such as feelings, perceptions, thoughts, or visual imagery. For instance, the following memory, as evoked by a patient with AD was attributed four points as it described a specific event situated in time and space enriched with emotion: “when I was young, I always wanted to drive my dad’s car but

he always refused to let me drive. One night I waited for him to fall asleep and I sneaked into my parents' room and took the key. Even though I'd never driven before, I was able to drive for a couple of streets until the car crashed into an electrical box... I was at the same time excited and afraid". The same score was attributed to the following memory, evoked by a control participant, as it described a specific event situated in time and space enriched with emotion: "in my childhood, I used to ask a lot of questions on everything, especially at school, I remember one day at school when I asked the teacher a question about his salary while he was explaining a math problem, it was an awkward question and the teacher was angry".

To avoid a bias in scoring, a second independent rater, blind to group assignment, rated a random sample of 20% of the data; an inter-rater agreement coefficient of 0.84 or higher was obtained (Shrout & Fleiss, 1979). Cases of disagreement were examined and discussed until a consensus was reached.

### **2.2.2. "Who am I?" task**

We replicated the procedures of Charlesworth et al. (2015) and Addis and Tippett (2004). Participants had to produce 20 verbal statements to the question "Who am I?". They were instructed that they had to provide very short statements beginning with the phrase "I am" that they felt were essential in defining who they are. Participants were instructed that responses should reflect stable and enduring aspects of their identity. These aspects might include roles, personality traits or physical traits. Participants were allowed one minute and the duration was made explicit from the outset so that they could plan accordingly.

Data were coded according to three categories: physical self, social self and psychological self. In line with the procedures of Rathbone, Conway, and Moulin (2011), statements were considered as describing physical self if they reflected attributes that were apparent from appearance (e.g., some statements as provided by AD patients: I am beautiful, I

am sick, I am old, I am thin, I am alive; some statements as provided by controls: I am beautiful, I am old, I am free, I am strong, I am healthy), social if they reflected a social attribute or role (e.g., some statements as provided by AD patients: I am grandmother, I am grandfather, I am a good neighbor, I am volunteering; some statements as provided by controls: I am worker, I am retired, I am father, I am volunteering), and psychological if they reflected a personality trait (e.g., some statements as provided by AD patients: I am honest, I am confident, I am friendly, I am helpful, I am faithful; some statements as provided by controls: I am trustworthy, I am reliable, I am sincere, I am polite, I am curious), or an emotional state (e.g., some statements as provided by AD patients: I am happy, I am calm, I am anxious, I am nervous, I am sad; some statements as provided by controls: I am happy, I am glad, I am joyful, I am optimistic, I am nervous). In line with the recommendations of Rhee, Uleman, Lee, and Roman (1995), statements describing two self-dimensions were analyzed in terms of the principal unit. For instance, the statement “I am a good mother” was attributed to social self as the unit (“a mother”) is the principal unit of meaning, rather than the evaluation (“good”). When responses contained several closely related meanings (e.g., “I am decent and honest”), only the first meaning was coded. Repeated statements and those not beginning with “I am” were excluded (for instance, some participants answered “I like to be decent”, an answer that was not taken into account). Vague descriptions were also excluded (e.g., “I will be someone”). Data were coded by two independent judges and a post-coding comparison revealed 90% agreement between judges. Cases of disagreement were discussed until a consensus was reached.

The score referred to the total number of statements, as well as the number of those that were attributed to each self-category.

### 2.3. Results

We first compared differences on autobiographical specificity between groups. We then compared differences on the production of “Who am I?” statements after autobiographical retrieval vs. after the verbal fluency task. Owing to abnormal distribution of the data, non-parametric tests were conducted. Significant results are provided with effect size:  $d = .2$  can be considered a small effect size,  $d = .5$  represents a medium effect size and  $d = .8$  refers to a large effect size (Cohen, 1988). Note that effect size was calculated for non-parametric tests following the recommendations by Rosenthal and DiMatteo (2001), and Ellis (2010). For all tests, the level of significance was set at  $p \leq 0.05$ ,  $p$  values between 0.051 and 0.10 were considered as trends, if any.

#### 2.3.1. Low autobiographical memory in AD patients

Scores on the assessment of autobiographical specificity are shown in Figure 1. Relative to controls, AD participants showed lower autobiographical specificity ( $Z = -3.59$ ,  $p < .001$ , Cohen’s  $d = 1.13$ ).

[INSERT FIGURE 1 APPROXIMATELY HERE]

#### 2.3.2. More “Who am I?” statements after autobiographical retrieval

The numbers of “Who am I?” statements are depicted in Table 2. Wilcoxon signed rank tests revealed more total statements after autobiographical retrieval than after the control task in AD patients ( $Z = -4.05$ ,  $p < .001$ , Cohen’s  $d = 3.28$ ) and control participants ( $Z = -3.70$ ,  $p < .001$ , Cohen’s  $d = 1.77$ ). More physical-self statements were produced after autobiographical retrieval than after the control task in AD patients ( $Z = -2.45$ ,  $p < .05$ , Cohen’s  $d = 1.09$ ) and control participants ( $Z = -1.96$ ,  $p < .05$ , Cohen’s  $d = .75$ ). More social-self statements were produced after autobiographical retrieval than after the control task in AD patients ( $Z = -3.31$ ,  $p < .01$ , Cohen’s  $d = 1.60$ ) and control participants ( $Z = -2.65$ ,  $p < .01$ ,

Cohen's  $d = 1.47$ ). More psychological-self statements were produced after autobiographical retrieval than after the control task in AD patients ( $Z = -2.24$ ,  $p < .05$ , Cohen's  $d = .93$ ) and control participants ( $Z = -3.47$ ,  $p < .01$ , Cohen's  $d = 1.59$ ).

Mann-Whitney U tests revealed fewer total "Who am I?" statements in AD patients than in control participants after autobiographical retrieval ( $Z = -4.03$ ,  $p < .001$ , Cohen's  $d = 1.23$ ) and after the control task ( $Z = -3.48$ ,  $p < .001$ , Cohen's  $d = 1.01$ ). Fewer physical-self statements were generated by AD patients than by control participants after autobiographical retrieval ( $Z = -2.41$ ,  $p < .05$ , Cohen's  $d = .66$ ) and after the control task ( $Z = -2.11$ ,  $p < .05$ , Cohen's  $d = .57$ ). Fewer social-self statements were generated by AD patients than by control participants after autobiographical retrieval ( $Z = -2.71$ ,  $p < .01$ , Cohen's  $d = .75$ ) and after the control task ( $Z = -2.95$ ,  $p < .01$ , Cohen's  $d = .83$ ). Fewer psychological-self statements were generated by AD patients than by control participants after autobiographical retrieval ( $Z = -3.50$ ,  $p < .001$ , Cohen's  $d = 1.02$ ) and after the control task ( $Z = -2.41$ ,  $p < .05$ , Cohen's  $d = .66$ ).

Friedman tests revealed significant differences between production of physical-self statements, social-self statements, and psychological-self statements after autobiographical retrieval in AD patients [ $X^2(2, N = 28) = 10.59$ ,  $p = .002$ , Cohen's  $d = 1.61$ ] and control participants [ $X^2(2, N = 30) = 7.93$ ,  $p = .011$ , Cohen's  $d = 1.17$ ]. Wilcoxon signed rank tests revealed fewer physical-self statements than social-self statements in AD patients ( $Z = -2.43$ ,  $p < .05$ , Cohen's  $d = .62$ ) and control participants ( $Z = -2.22$ ,  $p < .05$ , Cohen's  $d = .52$ ), fewer physical-self statements than psychological-self statements in AD patients ( $Z = -2.97$ ,  $p < .05$ , Cohen's  $d = .69$ ) and control participants ( $Z = -2.79$ ,  $p < .05$ , Cohen's  $d = .63$ ), but similar numbers of social-self and psychological-self statements in AD patients ( $Z = -1.54$ ,  $p > .1$ ) and control participants ( $Z = -.90$ ,  $p > .1$ ).

Friedman tests also revealed significant differences between production of physical-self statements, social-self statements, and psychological-self statements after the control task in AD patients [ $X^2(2, N = 28) = 7.83, p = .012, \text{Cohen's } d = 1.26$ ] and control participants [ $X^2(2, N = 30) = 8.63, p = .01, \text{Cohen's } d = 1.27$ ]. Wilcoxon signed rank tests revealed fewer physical-self statements than social-self statements in AD patients ( $Z = -2.51, p < .05, \text{Cohen's } d = .59$ ), and control participants ( $Z = -1.96, p < .05, \text{Cohen's } d = .55$ ), fewer physical-self statements than psychological-self statements in AD patients ( $Z = -3.07, p < .001, \text{Cohen's } d = .69$ ), and control participants ( $Z = -2.52, p < .05, \text{Cohen's } d = .60$ ), but similar numbers of social-self and psychological-self statements in AD patients in AD patients ( $Z = -1.29, p > .1$ ) and control participants ( $Z = -.75, p > .1$ ).

Table 2

*Number of “Who am I?” statements with regard to the three self-dimensions in Alzheimer’s disease (AD) patients and control participants after autobiographical retrieval and the verbal fluency task.*

	Alzheimer		Older adults	
	Autobiographical	Verbal fluency	Autobiographical	Verbal fluency
<b>Physical self</b>	2.57 (1.92)*	1.50 (1.20)	3.94 (2.22)*	2.71 (2.30)
<b>Social self</b>	3.61 (1.42)**	2.36 (1.16)	4.97 (2.11)**	3.55 (1.75)
<b>Psychological self</b>	3.96 (1.62)*	2.82 (1.49)	5.65 (1.76)**	3.77 (1.71)
<b>Total</b>	10.14 (3.15)***	6.68 (2.11)	14.55 (4.14)***	10.03 (3.82)

*Note.* Standard deviations are given between brackets; differences between conditions were significant at: \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

### 3. Discussion

This study assessed whether autobiographical retrieval would enhance the sense of self in AD. Results revealed better production of descriptions related to physical self, social self and psychological self after autobiographical retrieval than after the control verbal fluency task in AD patients and control participants.

The main finding was the positive effect of autobiographical retrieval on the production of descriptions related to three self-dimensions in AD. This outcome is of interest as AD has been found to compromise both autobiographical retrieval and the sense of self (for a review, see (El Haj, Antoine, Nandrino, & Kapogiannis, 2015)). There is thought to be a relationship between autobiographical compromise and disruption of the sense of self in the disease (Addis & Tippett, 2004; Mograbi et al., 2009; Morris & Mograbi, 2013). The causality of this relationship was explored in a previous study demonstrating that retrieval of

self-related information may enhance autobiographical retrieval in AD (El Haj & Antoine, 2017). Previous research has also demonstrated beneficial effects of self-reference on recognition memory in AD (Kalenzaga, Bugajska, & Clarys, 2013; Kalenzaga & Clarys, 2013). The present study extends those findings by demonstrating a positive effect of autobiographical retrieval on the sense of self in the disease. The relationship between autobiographical memory and self in AD seems to be bidirectional, i.e. the retrieval of autobiographical memories may activate self-related information and vice-versa. This assumption fits with the Self Memory System (Conway, 2005; Conway & Pleydell-Pearce, 2000), according to which autobiographical memory is fundamental to the formation and maintenance of the self over time. In particular, the Self Memory System considers that self-related goals act as control processes or as the source for regulation of memory (Conway, 2005; Conway & Pleydell-Pearce, 2000). The present findings and those of previous research (El Haj & Antoine, 2017) extend the Self Memory System by providing empirical support for a bidirectional relationship between autobiographical memory and the self in AD. Our theoretical conceptualization also extends a previous model on the relationship between autobiographical memory and the self in AD (the AMAD model (El Haj, Antoine, Nandrino, & Kapogiannis, 2015)). The latter model suggests a unidirectional flow in which autobiographical compromise affects the sense of self in AD; i.e. autobiographical generality, anterograde amnesia and retrograde amnesia in AD are considered to result in a limited access to memories that shape self-knowledge.

Our AD participants produced fewer self-related statements than the control participants, suggesting a compromise of the ability to retrieve self-related information in the disease. These findings mirror those of Addis and Tippett (2004) who found a diminished ability to produce “Who am I?” statements in AD. They also fit with studies demonstrating a diminished ability to retrieve self-defining memories in AD (El Haj, Antoine, Nandrino, Gely-

Nargeot, et al., 2015; Martinelli et al., 2013). Moreover, they demonstrate a diminished ability to produce images related to specific self-dimensions, as the AD patients produced fewer physical-self, social-self, and psychological-self statements than the controls. Hence, AD seems to compromise different facets of the self. Not surprisingly, the disease affects the physical, social and psychological well-being of patients. Another finding was the lower production of statements related to physical self than to social self or psychological self in AD patients, a result already reported by Addis and Tippett (2004). The lower production of physical-self statements could be due to the effects of AD on the physical wellbeing of patients.

Regarding the controls, they also benefited from autobiographical retrieval to enhance production of self-related information. This is of interest as research suggests that healthy older adults are generally deficient in retrieving specific autobiographical memories, while their capacity to generate self-semantic knowledge seems relatively well-preserved (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Piolino et al., 2010; Piolino et al., 2002; St Jacques & Levine, 2007). The way in which healthy older adults remember their past might influence their sense of self. In line with this assumption, Prebble, Addis, and Tippett (2013) suggested that self-continuity in normal aging is maintained by autobiographical memory; autobiographical knowledge, especially semantic knowledge, promotes narrative continuity as semantic knowledge can be used to synthesize and organize many personal events into a coherent life story (Prebble et al., 2013). The control participants in the present study demonstrated high autobiographical specificity, so the increased production of self-related information was probably supported by the production of specific rather than semantic autobiographical knowledge. Activation of specific autobiographical memories might have provided the control participants with more access to self-knowledge than the control verbal fluency task did. Another finding in the control participants was the lower production of

statements related to physical self than to social self or psychological self compared to AD patients, a finding already reported by Addis and Tippett (2004). The decrease in the production of physical-self statements may reflect how healthy older adults perceive senescence and some negative changes in their physiological functioning (for a review on the effects of aging on physical functioning, see (Bherer, Erickson, & Liu-Ambrose, 2013).

A potential limitation of this study is the lack of assessment of time period from which the memories provided by participants were elicited. This issue is important because participants might retrieve memories from reminiscence bump. Reminiscence bump refers to the tendency of older adults to recall events from young adulthood with more specificity and volume than other life periods, critically, the reminiscence bump includes self-defining memories, i. e., those events that are specific, vivid, affectively intense, and which include enduring concerns about oneself (Singer, Rexhaj, & Baddeley, 2007). Future research should therefore consider whether the increased production of self-related information in AD patients may be supported by the production of self-defining memories. Future research should also consider other self-conceptualizations. For instance, Clare, Marková, Roth, and Morris (2011) suggested a model in which the self is divided into four different components: sensory registration, performance monitoring, evaluative judgment, and meta-representation. Another conceptualization of the self was proposed by S. B. Klein et al. (2003) who defined five components of the self: specific personal memories, facts about one's personal history, representations of one's own personality traits, experience of personal agency, and the ability to introspect one's own internal experiences.

Regardless of its potential limitation, this study is of clinical relevance as it shows that autobiographical retrieval could be used as a tool to activate the sense of self in AD. Clinicians could use this easy-to-administer instrument to activate the sense of self, an issue

of critical value for clinicians and caregivers who struggle to preserve patients' well-being and quality of life.

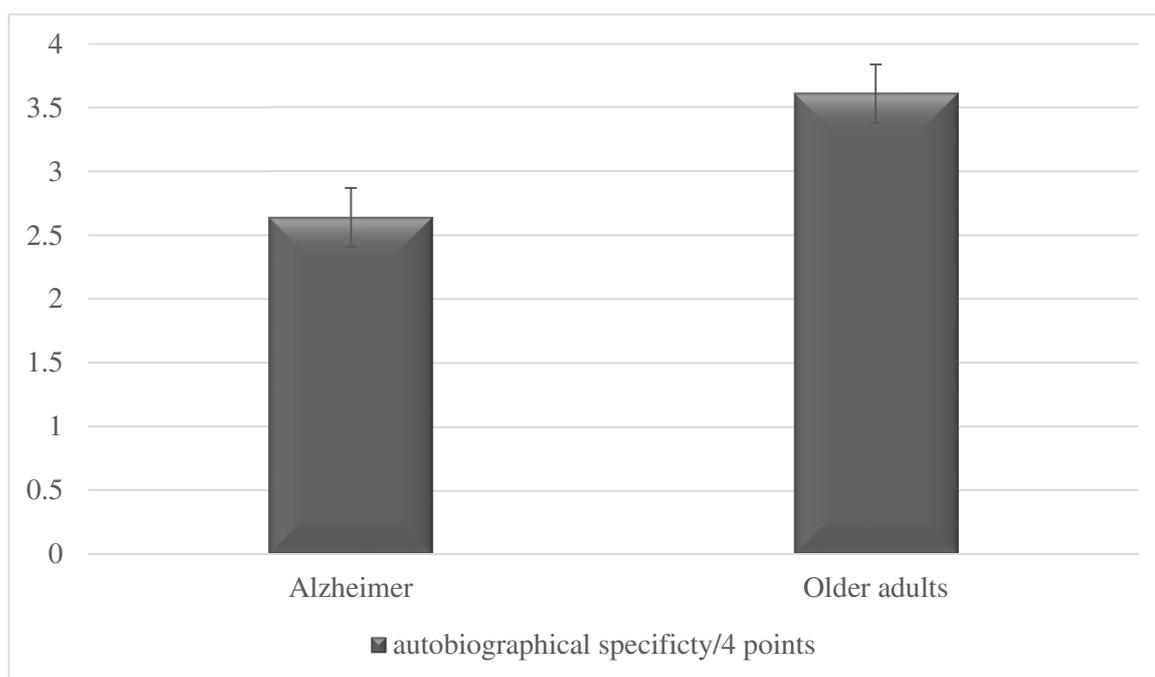
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**Figure 1**  
Autobiographical performance in Alzheimer's disease patients and control participants. Error bars represent intervals of 95 % within-subject confidence.