Self-Reference Effect and Autonoetic Consciousness in Alzheimer Disease

Evidence for a Persistent Affective Self in Dementia Patients

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Abstract: Episodic memory deficits are predominately the first cognitive impairment in Alzheimer disease (AD). Previous studies have demonstrated that these deficits are specifically linked to autonoetic consciousness impairment, whereas noetic consciousness remains preserved in AD. This study focused on the self-reference effect and examined emotional valence, as it has been shown that emotional content can enhance memory in AD. A task involving recognition of emotional versus neutral adjective traits after self-reference versus semantic encoding, and using the Remember/Know/Guess paradigm was administered to 22 AD patients and 18 normal controls. Results for AD patients show that self-reference increased autonoetic consciousness only for emotional and particularly negative trait adjectives. This interesting result indicates that neutral valence does not allow properties of the self to emerge in AD patients because of the progressive loss of the sense of self-linked to the disease, whereas emotional valence does.

Key Words: Alzheimer disease, self-reference effect, memory, states of awareness, emotional valence

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Alzheimer disease (AD) leads to increasing difficulty in activities of daily living as the brain disorders caused by this neurodegenerative pathology develop. Episodic memory impairment is usually considered to be one of the earliest and most severe deficits in AD, because the hippocampal complex, which plays a key role in the establishment of new memories, is one of the first regions to be affected by the disease. The memory deficits of AD are characterized by a temporal gradient with patients showing impaired ability to learn new information but remaining able to retrieve very old memories.

Apart from a severe and progressive decline of episodic memory, semantic memory deficits appear to emerge early in the course of the disease,[1] as shown by poor performance on category fluency tasks,[2] naming and semantic matching of words and pictures,[3] and definitions.[4] However, the nature and time of onset of these impairments remain ill-defined. According to some authors, AD patients may retain semantic information, the store of this kind of information remaining relatively intact, but they can no longer access the meaning of this knowledge.[5] Other authors suggest that there is a breakdown in the organization and structure of semantic knowledge, and that knowledge concerning specific concepts and their attributes is actually lost during the course of the disease.[6] Thus, patients gradually become unable to use the semantic organization of words as a way of improving their memory performance for example.

Episodic and semantic memory can be assessed experimentally in the same memory task using the Remember/Know/Guess procedure,[7,8] in which participants are asked to state the nature of their recollective experience during recognition. They are instructed to give a R response if the retrieval of the previously presented item is accompanied by details of its prior occurrence. This kind of response is assumed to involve autonoetic consciousness, which gives an impression of reliving previous events and experiences, or in other words, mentally traveling back in time,[9,10] and is an important characteristic of episodic memory. In contrast, participants give a K response if the retrieval of the target item is not accompanied by any conscious recollection of the encoding context. This kind of response is assumed to reflect noetic consciousness, or in other words, awareness of information without recall of phenomenal details, which corresponds to the functioning of semantic memory. With regard to AD, previous studies reported that patients produced fewer R responses than normal controls, but the same number of K responses,[11,12] or a higher number of K responses.[13] In 1 study, AD patients showed decreased sensitivity for both R and K responses compared with control and amnestic mild cognitive impairment patients.[14] Overall, this pattern of results therefore confirms that autonoetic consciousness, and thus episodic memory, is specifically impaired in AD, whereas the capacity to retrieve new decontextualized information is retained, at least up to the middle stage of the disease.

Numerous authors have argued that AD patients' difficulty in encoding might be linked to their inability to use semantic information, probably due to an impaired access to knowledge of the specific attributes of the concepts.[15] It has been shown that AD patients have difficulty using cognitive support to improve memory,[16] for example, categorical organization of the to-be-remembered items, which could be due to an impaired access to information stored in the semantic memory.[17] For example, Dalla Barba and Goldblum[18] have shown that in AD, and in other pathologies such as aphasia,[19] once the knowledge of an item has been lost, it can no longer be recognized in a subsequent episodic memory task. In their study, they manipulated instructions at encoding: in the first experiment, participants were given no instruction, and in the

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second, they had to process target items semantically. Interestingly, they found that AD patients who failed to analyze a given item semantically did not recognize the item in the subsequent recognition memory test. The authors interpreted these results with reference to the coordination hypothesis,[20] which states that "retrieval or use of information stored in memory is limited to a level of awareness at the time of original experience at encoding" (p.293). According to this theory, if knowledge of a to-be-encoded item is lost or incomplete, then episodic retrieval of that item (when it is possible) will occur "at a level of semantic awareness compatible with the level of semantic awareness at the time of encoding." Hence, AD patients are not able to improve their episodic memory performance by semantic encoding.

To get round this problem explained by the coordination hypothesis in relation to AD patients, we chose to work on 1 facet of a concept, awareness of which is considered to be specifically and deeply human: the concept of self. The self is known to be a well-developed cognitive structure that promotes elaboration and organization of the to-be-encoded information and also provides compatible encoding and retrieval conditions.[21] Numerous studies have shown that memory is enhanced more by processing information with reference to the self than by semantic processing. This phenomenon is known as the "self-reference effect (SRE)"[21,22] and has been found consistently under a variety of conditions. With regard to recollective experience, some studies have shown that a self-reference condition at encoding leads to higher rates of R responses, but has no effect on the rates of K responses.[23,24] These results are coherent considering that the notion of recollective experience is closely linked to the concept of the self because the former necessarily requires the latter.

As far as AD is concerned, there is some evidence that self-awareness is relatively preserved at least up to the middle stage of the disease.[25] Furthermore, self-reference judgments assume an affective component,[26] and emotion has the capacity to enhance memory.[27] Processing information with reference to the self typically evokes emotion, and this might contribute to the memory improvement associated with SRE, as emotional information is more vividly remembered than neutral information, particularly when it concerns personal past events or self-identity. Therefore, individuals may rehearse emotional more than neutral information,[28] and it is this increased rumination that could mediate the self-reference enhancement effect. Consequently, we can hypothesize that when participants have to encode items with reference to themselves, the more salient the emotional valence of the to-be-encoded material, the stronger the memory enhancement will be.

With regard to AD, studies that have investigated the hypothesis of a normal emotional memory enhancement effect in the course of the disease have produced mixed results. On the one hand, some studies have shown an impairment in the enhancement effect for negative pictures,[29–31] others for positive pictures,[29,31] for negative and positive words, negative sentences,[31] or positive and negative short stories.[32] On the other hand, some authors have demonstrated a relatively intact enhancement effect in AD for positive pictures,[30] negative stories,[33] and real-life events (the Kobe earthquake).[34] These studies are difficult to compare because they differ widely both in the material used and in the characteristics of the patient populations (eg, sample size or disease severity). The choice of material seems to be of particular importance because, according to Kensinger et al,[32] the studies that found blunted emotional memory enhancement in AD used stimuli that lacked semantic coherence, whereas the majority of studies that found an enhancement effect in AD used stimuli with semantic coherence (eg, real-life event or narrated slide show). Hence, the choice in the present study to invite participants to process emotional words with reference to the self as material linked to their self should be more coherent for AD patients. Thus, we can expect AD patients' attention to be attracted by the emotional valence of material that is potentially congruent with their self, as the most concrete and coherent stimuli for an individual are those that match features of his/her own personality.

The purpose of this study was to investigate the effect of emotional words encoded with reference to the self on the state of consciousness associated with memory retrieval in AD. On the basis of previous research,[11–13] we expected that AD would lead to lower rates of R responses but higher rates of K responses similar to those of controls. It was not easy to make a specific prediction about the effect of the disease on the encoding condition, because, as far as we know, only 1 study has investigated the SRE in AD patients.[35] The authors explored the links between the self and memorization of information in AD and reported a persistence of SRE. However, the self-consciousness deficits of AD patients have been shown to be relatively heterogeneous, with differences in their expression and time of onset, some authors reporting that the self remains intact throughout the course of the disease,[25] but other researchers stating that AD leads to the progressive death of the self.[36] Given these conflicting results, it is hard to make a clear hypothesis about the potential effect of the disease on the SRE. Nevertheless, we can assume that the self-reference condition would be more beneficial than semantic encoding for AD patients' recognition memory because of their well-known difficulty using semantic knowledge at encoding. More precisely, thanks to the self-reference properties, which promote compatible encoding and retrieval conditions,[21] the SRE should improve AD patients' recollective experience, in particular by helping retrieve encoding sequence details in a more personal way. With regard to the processing of emotions, we can assume that this variable might contribute to the improvement of the patients' autonoetic consciousness, an effect that might be enhanced under the self-reference condition. In accordance with Kensinger et al,[32] we assume that adjective traits encoded with self-reference would be sufficiently coherent for patients, enabling them to benefit from the emotional valence. In other words, we expected the patients' rates of R responses to be highest in the recognition of judgment of emotional words encoded under the self-reference condition. Furthermore, it has been shown that positive information (eg, trait adjectives such as "nice") is recalled better than negative information (eg, trait adjectives such as "rude") when it is processed with reference to the self, but not when it is processed semantically or with reference to another person.[37] In other words, when processing information with reference to themselves, individuals may emphasize positive and ignore negative information to preserve the positive conception they have of themselves. Therefore, we can expect our 2 groups to show a positivity bias when processing information with reference to themselves, leading to a higher rate of R responses for self-encoded positive than negative traits.

METHOD

Participants

A total of 40 participants were included in the study: 22 AD patients (20 women, 2 men) aged 67 to 96 years with an Mini Mental State Examination (MMSE) score[38] of 24 or lower, and 18 elderly normal controls (16 women and 2 men) aged 75 to 99 years with an MMSE score of 25 or above. The MMSE is a widely used measure of cognitive impairment yielding a maximum score of 30. AD patients were recruited from nursing homes and diagnosed for probable AD in accordance with National Institute of Neurological and Communicative Diseases and Stroke-Alzheimer's Disease and Related Disorders Association standards.[39] Normal control participants were also recruited from nursing homes. Participants with a history of alcoholism or psychiatric illness were excluded from the study. All participants were native French speakers and had normal or corrected-to-normal hearing and vision.

The demographic characteristics of both groups are shown in Table 1. The groups did not differ significantly in age, years of education, or depressive symptomatology. AD patients scored lower on the MMSE,[38] Mattis Dementia Rating Scale,[40] and the 5-word test.[41]

Materials and Design

Participants performed an encoding task and a recognition task using the Remember/Know/Guess procedure.

Encoding

Two lists of 30 personality-trait adjectives were selected from a normalized pool[42] [In Anderson's] list, 555 personality-trait adjectives had been rated on meaningfulness by 50 subjects and on likableness by 100 subjects. The scale for meaningfulness ranged from 0 (I have almost no idea of the meaning of this word) to 4 (I have a very clear and definite understanding of the meaning of this word). Consequently, trait adjectives had been rated from 386 (easily meaningful) to 288 (hardly meaningful). The scale for likableness ranged from 0, being defined as "least favorable or desirable," to 6, defined as "most favorable or desirable." Consequently, trait adjectives had been rated from 573 (very favorable) to 26 (not at all favorable)] in which they had been rated moderate to highly meaningful, with meaningfulness ratings ranging from 322 (moderately meaningful) to 386 (highly meaningful; mean meaningfulness ratings of 361.8 for 1 list and 362.87 for the other one).

TABLE 1. Means and SDs of Age, Education, and Neuropsychological Measures for the 2 Groups

	AD (n = 22)		Controls (n = 18)		
	M	SD	*M*	SD	$t_{1,38}$
Age (y)	83.59	7.10	85	7.50	−0.61
Education (y)	8.18	1.18	8.28	1.41	−0.23
MMSE	18.09	3.54	27.56	1.62	−10.46***
MDRS	102.36	11.80	129.39	7.70	−8.36***
GDS	2.86	2.05	3.22	2.21	−0.53
5-word test	6.68	2.08	9.56	0.86	−5.49***

***$P < 0.001$.

AD indicates Alzheimer disease; GDS, Geriatric Depression Scale; MDRS, Mattis Dementia Rating Scale; MMSE, Mini Mental State Examination.

The 2 lists were equated for word length (mean number of letters of 7.77 for 1 list, and 8.17 for the other one) and valence, so that each list was composed of 10 positive, 10 negative, and 10 neutral trait adjectives. In the present study, a word was considered to be positive if it has been rated from 573 to 428, neutral if it has been rated from 374 to 256, and negative if it has been rated from 223 to 26. One list was presented at encoding and provided target items for the following recognition test, whereas the other list provided lures. The recognition list consisted of a random mixture of items from the 2 sets. The 2 lists were counterbalanced across participants, so that within each group, half the participants learned 1 list, and half the other one.

Procedure

Participants were assessed individually, and gave their informed consent before participating in the experimental procedures. They were informed that the aim of the study was to explore memory and that they would be presented with words that they would have to remember for a subsequent memory test (intentional learning). The learning phase was divided into 2 sessions corresponding to the 2 encoding conditions. For the first 15 words (5 positive, 5 negative, and 5 neutral words), participants had to read aloud the words and propose a short definition (semantic encoding). All the participants (both normal controls and AD patients) were able to give a definition for all the words. For the other 15 words (5 positive, 5 negative, and 5 neutral words), they had to answer the question "*To what extent does this adjective describe you?*" (self-referential encoding) using a 4-point rating scale ranging from "*Not at all*" to "*Completely*." In the case of any understanding problem, a short definition of the adjective was given to the patient so that both normal controls and AD patients could perform the task correctly. The adjectives were printed on cards (card size: 10.5×2 cm, font size: 48) and were presented randomly, 1 at a time for approximately 5 seconds each.

For AD patients, recognition was tested 1 minute after presentation of the word sets. For controls, there was a 10-minute retention interval during which they carried out other tests. This was to reduce the risk of a ceiling effect in recognition performance in the control group and the risk of a floor effect in the AD group. The recognition task was associated with the Remember/Know/Guess paradigm.[7,8] The complete set of 60 words (30 targets and 30 lures) was presented in a single constant and random order, typed in 1 column. The participants were required to underline the words they recognized from the study list and to indicate whether or not they had a conscious recollection of the learning sequence. They were instructed to give an R response when they recognized a word, if their recognition was accompanied by the ability to mentally travel back in time and reexperience something about its presentation. Examples included remembering a word because it brought to mind a particular association, image, or some other personal experience. In contrast, participants were instructed to give a K response if they recognized a word and felt confident that it was in the study list but could not give any detail about its encoding. Finally, participants were told that if they were not sure whether the word belonged to the study list, they should give a Guess response.[43] This alternative was provided to ensure that K responses did not reflect a degree of uncertainty.

To make sure that participants understood all the recognition instructions, the experimenter helped them to

complete the task by repeating the instructions as often as necessary throughout the recognition task. In this way, the experimenter could also check that participants processed each successive item without going back to the previous one. Moreover, participants were asked to justify each R response by providing details of the encoding sequence to ensure that these responses really involved recollection processes. None of the participants was excluded on the basis of his explanations.

Scoring and Statistical Analysis

The dependent variables were based on the proportions of correct R and K responses with respect to the recognition hits (#R hits/# recognition hits) for each experimental condition. The R hits rate was computed including only the R responses for which the participants correctly recalled what the encoding condition was and what they evoked at the encoding stage (ie, R justified[44]). R justified ensures that correct R responses did not depend on a potential AD patients' liberal responses bias, which is very important because the main results of this study are based on R responses. G responses were included to compute these scores, but they were not analyzed independently because the interest of this category of response was to enhance the quality of K responses. They were also judged to be too low.

Although the main results concern the R and K responses, we present first the analysis for the proportions of correct recognitions for each experimental condition, independent of the R and K responses. Then, we present the analysis of R responses and the analysis of K responses. We conducted a 2 (groups: Alzheimer patients vs. normal controls) $\times 2$ (encoding conditions: semantic vs. self-reference) $\times 3$ (emotional valence: positive vs. negative versus neutral) analysis of variance to examine the effects of these 3 variables on overall recognition, R and K responses. Group was considered as a between-subjects factor, whereas encoding conditions and emotional valence were considered as within-subjects factors.

RESULTS

Overall Recognition

Figure 1 shows the proportions of overall correct recognition by group, encoding condition, and emotional valence.

The analysis revealed a main effect of group, $F_{1,38} = 9.09$ $P < 0.01$, $\eta^2_P = 0.19$, showing that overall, AD patients produced fewer correct responses than normal controls. Furthermore, a main effect of encoding condition, $F_{1,38} = 45.98$, $P < 0.001$, $\eta^2_P = 0.54$, indicated that the participants produced more correct responses for the words they encoded with reference to themselves than for the words they encoded semantically. Moreover, the interaction between group and encoding condition was not significant, $F_{1,38} < 1$, indicating that the 2 groups benefited equally from the SRE. This analysis also revealed an effect of emotional valence, $F_{2,76} = 4.99$, $P < 0.01$, $\eta^2_P = 0.11$, indicating that the participants produced more correct responses for positive than for negative words, $F_{1,38} = 9.77$, $P < 0.01$, $\eta^2_P = 0.20$, more correct responses for neutral than for negative words, $F_{1,38} = 6.12$, $P < 0.05$, $\eta^2_P = 0.14$, and the same rates of correct responses for positive and neutral words, $F_{1,38} > 1$. Finally, the interaction between group and emotional valence was significant, $F_{2,76} = 3.69$, $P < 0.05$, $\eta^2_P = 0.08$. Subsequent pairwise comparisons showed that normal controls produced the same rates of correct responses for positive and negative words, $F_{1,38} = 1.65$, the same rates of correct responses for positive and neutral word, $F_{1,38} = 3.08$, and more correct responses for neutral than for negative words, $F_{1,38} = 7.14$, $P < 0.05$, $\eta^2_P = 0.15$. AD patients produced the same rates of correct responses for negative and neutral words, $F_{1,38} < 1$, more correct responses for positive than for negative words, $F_{1,38} = 10.47$, $P < 0.01$, $\eta^2_P = 0.21$, and more correct responses for positive than for neutral words $F_{1,38} = 4.16$, $P < 0.05$, $\eta^2_P = 0.10$. The other interactions were not significant (all F's < 1).

Figures 2 and 3 show the proportions of R and K responses by group, encoding condition, and emotional valence (We divided the AD group as a function of MMSE score, with a cut-off of 19, and performed analysis of variance's on these 2 samples. Results did not differ from those found in the whole AD group).

Remember Responses

The analysis revealed a main effect of group, $F_{1,38} = 45.78$, $P < 0.001$, $\eta^2_P = 0.55$, showing that patients produced fewer R responses than normal controls. Furthermore, a main effect of encoding condition, $F_{1,38} = 25.64$, $P < 0.001$, $\eta^2_P = 0.40$, indicated that the participants produced more R responses for the words they encoded with reference to themselves than for the words

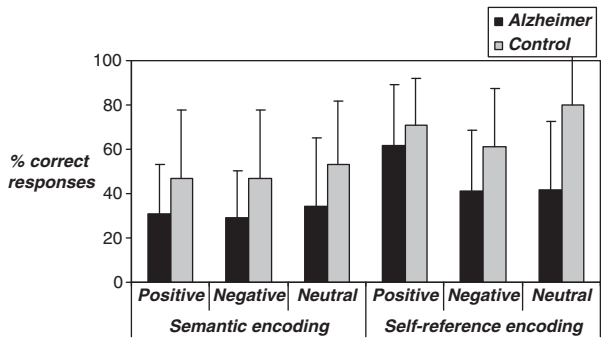

FIGURE 1. Mean proportions (and SDs) of overall correct recognition by group, encoding condition, and emotional valence.

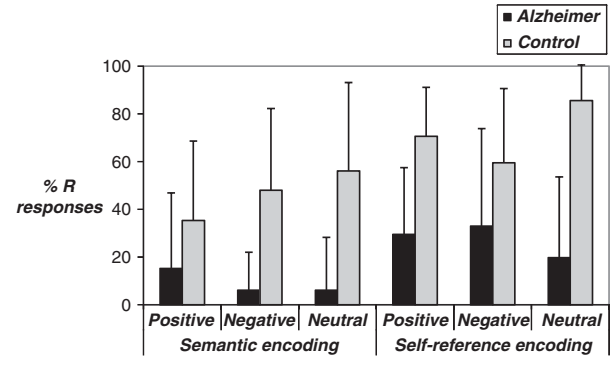

FIGURE 2. Mean proportions (and SDs) of correct Remember responses by group, encoding condition, and emotional valence.

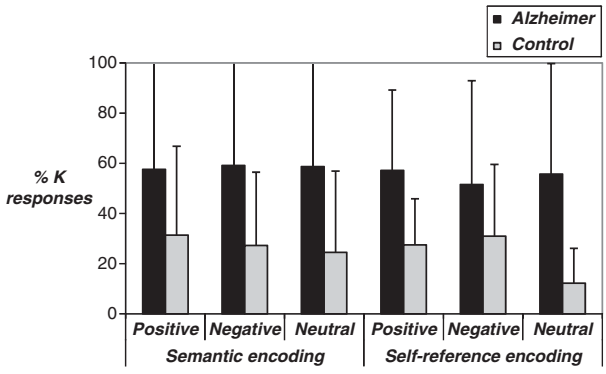

FIGURE 3. Mean proportions (and SDs) of correct Know responses by group, encoding condition, and emotional valence.

they encoded semantically. Moreover, the interaction between group and encoding condition was not significant, $F_{1,38} < 1$, indicating that the 2 groups benefited equally from the SRE. This analysis also revealed no effect of emotional valence, $F_{2,76} = 1.40$, $P > 0.05$, but the interaction between group and emotional valence was significant, $F_{2,76} = 9.97$, $P < 0.001$, $\eta^2_P = 0.21$. Furthermore, there was no significant interaction between encoding condition and emotional valence, $F_{2,76} < 1$, but there was a significant interaction between group, encoding condition, and emotional valence, $F_{2,76} = 3.32$, $P < 0.05$, $\eta^2_P = 0.08$. For the control group, subsequent pairwise comparisons showed that self-reference had an effect for positive words, $F_{1,38} = 15.95$, $P < 0.001$, $\eta^2_P = 0.30$, and for neutral words, $F_{1,38} = 10.50$, $P < 0.01$, $\eta^2_P = 0.22$, but not for negative words, $F_{1,38} = 1.46$, $P > 0.05$. For the AD group, self-reference had an effect for negative words, $F_{1,38} = 9.76$, $P < 0.01$, $\eta^2_P = 0.20$, a marginal effect for positive words, $F_{1,38} = 3.19$, $P = 0.08$, $\eta^2_P = 0.08$, but no effect for neutral words $F_{1,38} = 2.78$, $P > 0.05$. Further pairwise comparisons showed that, under the self-reference condition, AD patients had the same rate of R responses for positive and negative trait adjectives, $F_{1,38} < 1$, and that they produced more R responses for positive and negative trait adjectives together than for neutral adjectives, $F_{1,38} = 4.47$, $P < 0.05$, $\eta^2_P = 0.11$. Therefore, these results indicate that self-reference had an effect for the control group when participants had encoded positive and neutral words, but not when they had encoded negative words. Conversely, for the AD group, self-reference had a significant effect for emotional, and particularly negative, valence.

Know Responses

The analysis revealed a main effect of group, $F_{1,38} = 24.24$, $P < 0.001$, $\eta^2_P = 0.39$, showing that patients produced more K responses than normal controls. The other main effects and interactions were not significant (all F's < 1).

DISCUSSION

The purpose of the present study was to investigate the effect of 2 experimental variables, encoding condition and emotional valence, on the state of consciousness in AD. This line of research is innovative because very few studies have investigated the state of consciousness in AD, and to the best of our knowledge the SRE has only been tested once,[35] and previous findings about emotion processing are contradictory. Thus, little is known in this field of research on AD, and the aim of this study was to provide some initial elements.

Our first objective was to replicate previous findings showing impaired access to autonoetic consciousness and preserved access to noetic consciousness in AD.[11–13] Our data confirm that AD patients have a specific deficit of autonoetic consciousness leading to difficulty in mentally traveling back to a more or less distant past to reexperience past events. We can conclude that the declarative memory disorder that is characteristic of this pathology is mainly a deficit of episodic memory, AD patients remaining able to remember decontextualized information up to at least the middle stage of the disease.

Secondly, on the basis of studies that have explored the SRE on the state of consciousness in young[23] and older adults,[24] we investigated the effect of self-referential encoding on autonoetic and noetic consciousness in AD. In line with Lalanne et al's [35] findings, our results show that AD patients may benefit from the SRE and that this improves their episodic memory. As predicted, it appears that self-reference leads to a higher rate of R responses, but has no effect on the proportion of K responses. These results confirm that the notion of self is close to the concept of autonoetic consciousness, because, as observed by Tulving,[9] mental time travel necessarily requires a traveler. Moreover, the lack of interaction between group and encoding conditions indicates that AD patients and normal controls benefited equally from the SRE. This leads to the conclusion that although self-processing impairment has been reported in AD,[45] patients remain able, to some extent, to use properties of the self in a memory task, improving the quality of their recognition performance. This suggests that a certain self-awareness is preserved in mild to moderate AD. However, these results should be treated with caution regarding the study of the emotional valence effect.

The third objective of this research was to investigate the effect of emotional valence on the state of consciousness in AD. We hypothesized that AD patients could benefit from the effect of emotional valence to improve their autonoetic consciousness, in particular for the recognition of the adjective traits that they encoded with reference to themselves, because of the greater coherence and concreteness of this material. We also expected our 2 groups to show a positivity bias, whereby positive information would be recalled better than negative information when it was processed with reference to the self, but not when it was processed semantically or with reference to another person.[37] Our results demonstrated that emotional valence had no effect on the autonoetic consciousness scores of either group. This lack of effect could be explained by the interaction between group, encoding condition, and emotional valence, showing that the effect of emotional valence varied with the encoding condition in each group. This interaction shows that the self-reference condition only had an effect on the autonoetic consciousness of the normal controls for positive and neutral adjectives, indicating that when these participants had to relate information to their self, their attention was caught by the positive and neutral, but not by the negative valence. It therefore appears that self-reference had no effect on the autonoetic consciousness of normal controls when they encoded negative adjectives, as if they were reluctant to associate their personality traits with a

negative valence. We can interpret this as their desire to ignore the negative aspects of their personality. This is in line with previous studies showing a greater improvement in the recall of positive than negative self-encoded information.[37] In the aging context, this positivity bias can be interpreted according to the Socioemotional Selectivity Theory,[46] which assumes that as people get older, their perception of time running out and of approaching the end of life lead them to give priority to positive information and reject negative information to experience greater emotional well-being. Previous studies have demonstrated that older people attend to and remember positive information more than negative information.[47] We can therefore suppose that this was the case for our normal control participants: their attention was drawn to the positive and neutral aspects of their personality but not to the negative ones, may be to preserve positive self-esteem. This is supported by personality evaluation questionnaires in which normal controls rate their personality more positively than negatively (mean evaluation scores of 29.7/40 for positive traits vs. 15.4/40 for negative traits).

As far as AD patients are concerned, the interaction between group, encoding condition, and emotional valence shows a contrasting pattern of performance, as only negative valence had a significant effect on this group's autonoetic consciousness under the self-reference condition. However, the SRE was also marginally significant for the positive trait adjectives, and pairwise comparisons showed that there was no significant difference between the rates of R responses for positive and negative trait adjectives. This demonstrates that when AD patients had to relate information to their self, their attention was caught by the emotional valence, and the negative valence in particular. This interesting result indicates that neutral valence does not allow properties of the self to emerge in AD due to self-awareness deficits linked to the disease, whereas emotional valence does, presumably because of the importance of the affective component in the construction of identity and self. This confirms Kensinger et al's[32] proposition that AD patients may benefit from emotional valence provided it is applied to relevant material for this group. Thus, the SRE may help AD patients improve their autonoetic consciousness, but this effect occurs only with emotional valence, as if the self becomes salient only for emotional valence. This suggests that affective components are of particular importance in the construction of the self for AD patients. We can assume that AD patients, like the normal controls, emphasized the positive aspects of their self when processing information with reference to themselves. This is supported by the fact that they rated their personality very positively, as normal controls did (mean evaluation scores of 31.2/40 for positive traits vs. 12/40 for negative traits). Here again, this positive view of their personality may come from a desire to maintain a positive self-esteem, as seems to be the case for the normal control group. This mechanism might be reinforced in AD if, as suggested by psychodynamic theories about AD,[48] we assume that AD patients, even more than normal elderly people, are afraid of growing old. Thus, we can hypothesize that this group would be at least as inclined as normal controls to reject negative information and to deny the negative aspects of their personality to protect themselves from negative affects. Given that the AD patients did not evaluate their personality negatively (in contrast, they rated it very positively), the fact that self-reference had an effect on their autonoetic consciousness for negative trait adjectives is noteworthy. This negativity effect cannot be explained by depression, firstly because the AD patients' scores on the Geriatric Depression Scale were similar to those of the normal controls and did not reveal any depression, and secondly, this negativity bias occurred only when AD patients had to process information with reference to themselves. Furthermore, some authors have established that AD constitutes a threat to the self,[49] and they argued that AD patients tend to cope with this threat by ignoring their difficulties in the activities of daily living (ie, what is called anosognosia) through processes of denial. Thus, from that point of view, in the present study, AD patients would have rather rejected the negative consequences of the disease on self-concept.

Our results are consistent with the idea that the notion of self is close to the concept of autonoetic consciousness because they show that reflecting on one's self and linking the to-be-encoded information with the properties of the self improve recollective experience at recognition. It appears that while the SRE may help AD patients improve their recollective experience, this effect is significant only for emotional valence, and particularly for negative valence. This emotional bias might be based on the AD patients' unconscious belief that their self has something to do with negativity. For example, psychosocial theories of AD[50,51] emphasize the detrimental consequences of the negative view that society has of AD on AD patients' sense of self-worth. Thus, further research is required to investigate this hypothesis.

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