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Increasing the salience of fluency cues does not reduce the recognition memory impairment in Alzheimer's disease!

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In Alzheimer's disease (AD), it is now well established that recollection is impaired from the beginning of the disease, whereas findings are less clear concerning familiarity. One of the most important mechanisms underlying familiarity is the sense of familiarity driven by processing fluency. In this study, we attempted to attenuate recognition memory deficits in AD by maximizing the salience of fluency cues in two conditions of a recognition memory task. In one condition, targets and foils have been created from the same pool of letters (Overlap condition). In a second condition, targets and foils have been derived from two separate pools of letters (No-Overlap condition), promoting the use of letter-driven visual and phonetic fluency. Targets and foils were low-frequency words. The memory tasks were performed by 15 patients with AD and 16 healthy controls. Both groups improved their memory performance in the No-Overlap condition compared to the Overlap condition. Patients with AD were able to use fluency cues during recognition memory as older adults did, but this did not allow to compensate for dysfunction of recognition memory processes.

According to the dual-process models, recognition memory is supported by recollection and familiarity (for a review, see Yonelinas, 2002). Recollection allows the mental reinstatement of the previous episode in association with conscious retrieval of contextual details linked to the stimulus, whereas familiarity involves the feeling that an event was previously encountered without any recall of the specific contextual information of this event. Impairment of episodic memory is the earliest and most often reported cognitive decline in Alzheimer's disease (AD). Most studies revealed that recollection is affected in AD (Ally, Gold, & Budson, 2009; Budson, Wolk, Chong, & Waring, 2006; Gallo, Sullivan, Daffner, Schacter, & Budson, 2004; Hudon, Belleville, & Gauthier, 2009; Rauchs *et al.*, 2007; Westerberg *et al.*, 2006). In contrast, data concerning familiarity are less consistent. Some studies are in favour of an impairment of familiarity (Ally *et al.*, 2009; Hudon *et al.*, 2009; Westerberg *et al.*, 2006, 2013; Wolk, Mancuso, Kliot, Arnold, & Dickerson, 2013; Wolk, Signoff, & DeKosky, 2008), while

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others suggest a preservation of this function in AD (Genon *et al.*, 2013, 2014; Rauchs *et al.*, 2007). Different factors could explain these discrepant findings (for reviews, see Koen & Yonelinas, 2014; Schoemaker, Gauthier, & Pruessner, 2014; Simon & Bastin, 2014), such as the methods with which recollection and familiarity were assessed (e.g., Ally, 2012; Clark *et al.*, 2012; Westerberg *et al.*, 2006), the severity of the disease (Algarabel *et al.*, 2009; Fleischman *et al.*, 1999), the inherent properties of the stimuli (for a review, see Ally, 2012), or the integrity of mechanisms underlying familiarity (Simon & Bastin, 2015).

One of the most important mechanisms participating to familiarity is fluency processing. Enhanced fluency can result from prior exposure to the materials or from other variables such as characteristics of the stimuli (e.g., perceptual clarity, figure-ground contrast or symmetry; Reber, Schwarz, & Winkielman, 2004; for a review). In a memory task, when a stimulus is processed fluently due to its previous encounter, the associated feeling of efficiency or speed may be unconsciously interpreted as a sign of oldness (Jacoby & Whitehouse, 1989; Rajaram, 1993; Westerman, 2001; Whittlesea & Leboe, 2000; Whittlesea & Williams, 1998, 2000). The conversion of fluency into recognition relies on unconscious attributional processes involving inferences about the origin of the fluency feeling (Whittlesea & Leboe, 2000). If the feeling is assigned to a past exposure, this sensation takes the colour of a feeling of familiarity leading to consider this stimulus as old (Jacoby & Whitehouse, 1989; Miller, Lloyd, & Westerman, 2008; Unkelbach, 2006; Westerman, Lloyd, & Miller, 2002; Whittlesea & Leboe, 2000; Whittlesea & Williams, 2001a,b). The relationship between fluency and familiarity has been notably emphasized in studies using the remember/know paradigm (Gardiner, 1988; Tulving, 1985) in combination with various forms of fluency manipulation (Kurilla & Westerman, 2008; Lindsay & Kelley, 1996; Rajaram, 1993; Rajaram & Geraci, 2000; Willems & Van der Linden, 2006). Typically, manipulations that enhance processing fluency lead to an increase of know judgments and therefore of familiarity (Kurilla & Westerman, 2008; Lindsay & Kelley, 1996; Rajaram, 1993).

The feeling of fluency may come from the facilitation of various levels of cognitive operations. Traditionally, the authors made a distinction between perceptual and conceptual processing stages. Perceptual fluency refers to the ease with which a stimulus is processed on the basis of physical characteristics such as size, typography, or shape, whereas conceptual fluency refers to the ease with which a stimulus is processed on the basis of its meaning. These multiple facets of fluency raise the question of which processing stages are actually facilitated by previous encounter, and which aspects are intact or not in AD. The findings are not consensual concerning the integrity of conceptual fluency in the early stage of the disease. Various studies reported that patients with AD failed to benefit optimally from the repetition of conceptual processing in priming tasks (Fleischman, 2007; Fleischman *et al.*, 2005) and memory tasks (Gold, Marchant, Koutstaal, Schacter, & Budson, 2007; Keane, Gabrieli, Fennema, Growdon, & Corkin, 1991). Some studies suggest, nevertheless, the use of residual conceptual fluency for memory decision (Wolk *et al.*, 2005; Wolk, Gold, Signoff, & Budson, 2009; Yano, Umeda, & Mimura, 2008 [experiment 2]). The processing of perceptual fluency seems to be better preserved in AD. The majority of the studies that have manipulated and measured directly perceptual fluency via objective measures of performance (i.e., perceptual priming tasks) reported a relative preservation of its effect in AD (Ballesteros, Reales, & Mayas, 2007; Fleischman, 2007), at least in the early stage of the disease (for a review, Fleischman *et al.*, 1999). Can patients with AD use this intact perceptual facilitation to make memory decisions? Only few studies did not find any use of perceptual fluency in AD patients' recognition decisions (Algarabel *et al.*, 2009; Yano *et al.*, 2008 [Experiment 1]). In contrast, evidence of preserved interpretation of perceptual fluency as a memory sign in AD takes the form of an increased endorsement of fluent items as old in memory tasks (Ballesteros *et al.*, 2007; Fleischman, 2007; Fleischman *et al.*, 2005; O'Connor & Ally, 2010; Willems, Germain, Salmon, & Van der Linden, 2009). Perceptual fluency could thus play a major role in AD patient's memory. Thus, to manipulate this kind of fluency might help patients with AD to enhance recognition memory performance.

Therefore, the objective of the present experiment was to create an optimal context maximizing the salience of fluency cues so that patients with AD could process and use efficiently the associated feeling to reduce their memory deficits. In this context, an interesting paradigm that allows to enhance perceptual fluency in recognition memory has been developed by Parkin *et al.* (2001). Two recognition memory tasks represent two conditions. In the first condition, studied and unstudied words have been created from the same pool of letters (Overlap condition). Conversely, in the second condition, studied and unstudied words have been derived from two separate pools of letters (No-Overlap condition). This condition favours the use of letter-driven visual fluency to discriminate studied from unstudied items (in addition to whole-word fluency that was higher for studied words than unstudied words similarly in both conditions). In other words, the availability and salience of fluency cues are greater in the No-Overlap condition than in the Overlap condition. During these tasks, participants are typically not aware of the letter manipulation, so that associated enhanced letter-driven is attributed to prior exposure to the words. In young (Algarabel *et al.*, 2009; Lucas & Paller, 2013; Parkin *et al.*, 2001) and older participants (Algarabel *et al.*, 2009; Parkin *et al.*, 2001), recognition memory performance was better in the No-Overlap condition than in the Overlap condition, suggesting a preservation of the ability to benefit from a letter-driven visual and phonetic fluency source in recognition memory in normal ageing. Moreover, Keane, Orlando, and Verfaellie (2006) showed that increasing the salience of fluency by eliminating letter-level overlap between old and new stimuli significantly reduces the recognition deficit in patients with medial temporal lobe amnesia. Using this paradigm, Bastin, Willems, Genon, and Salmon (2013) showed that patients with mild AD benefited as much as healthy controls from these fluency cues to increase their recognition memory performance. However, the effect of this manipulation was moderate and not sufficient to significantly attenuate the amplitude of the memory deficits. In fact, patients with AD did not use fluency more than healthy controls. This result could be surprising because previous studies suggest that participants with poor memory may benefit to a greater extent from fluency cues for their recognition judgments (Verfaellie & Cermak, 1999).

If fluency cues are to be used as adequate levers to improve patients' memory efficiency in rehabilitation programs (Ally, 2012), one needs to further explore conditions that promote fluency-based recognition memory in AD. So, the goal of the present experiment was to create an optimal context where the availability of fluency cues is maximized and relevant for recognition decisions, in an attempt to significantly attenuate AD patients' memory deficits. In this context, one can either improve the absolute level of fluency of target items by increasing their intrinsic fluency level (e.g., by introducing a repetition of the items during encoding or by adding a prime in the recognition phase), or enhance the relative fluency by manipulating the gap between fluent items and non-fluent items. This is typically the case when reducing the overall pre-experimental fluency of items. Here we manipulated both absolute and relative fluency by increasing the salience of letter-level fluency cues in the context of very low-frequency words.

Using very low-frequency words may have three positive consequences. First, this manipulation can enhance the absolute fluency level. Typically, the recognition of low-frequency words is associated with higher hits and lower false alarms (FA) rates than recognition of high-frequency words (Glanzer & Adams, 1985, 1990; Glanzer, Adams, Iverson, & Kim, 1993; Glanzer & Bowles, 1976; Jacoby & Dallas, 1981). Some authors attributed this effect to the initial lower ease of processing for non-frequent words. The repetition of these words in an experimental context should enhance their absolute processing fluency to a considerably larger extent than for more frequent words. Indeed, frequent words have a higher baseline level of fluency which may give rise to a ceiling effect (Jacoby & Dallas, 1981; Mandler, 1980). Secondly, the relative difference in fluency level between old and new words may thus be exacerbated by the use of very low-frequency words. We reason that the influence of various forms of processing fluency (for instance, letter-level fluency in the present case) would be particularly powerful for low-frequency words as the fluency is experienced in a context in which the surrounding stimuli (the unstudied low-frequency words) are less fluent. Enhanced fluency due to the repetition of less frequent words could pop out from the overall non-fluent background and significantly impact recognition decisions (Jacoby & Dallas, 1981; Westerman, 2008). Third, fluency may be associated with a feeling of surprise. Indeed, enhancing discretely fluency by letter manipulation might make that processing more fluent than one could expect for those words. This surprising discrepancy between expectations and the actual fluency would induce attribution to prior encounter (e.g., Westerman, 2008; Whittlesea & Leboe, 2003; Whittlesea & Williams, 2001a,b).

Using Parkin *et al.*'s (2001) letter overlap paradigm in association with very low-frequency words that were read aloud at encoding, we multiplied the number of sources of fluency relevant for recognition decisions (enhancement of the salience of letter-level fluency, lexical fluency, and phonetic fluency). As the experimental set-up maximizes the opportunity to rely on fluency cues to make recognition decisions, one might reduce the performance gap between patients and healthy controls, replicating and extending the previous results obtained by Bastin *et al.* (2013). In this case, these results would bring further evidence in favour of the preservation of the use of word fluency in AD. Conversely, if patients with AD do not benefit from the optimal availability of fluency cues, this may suggest that some mechanisms underlying the use of fluency in the service of recognition memory are affected in AD.

Methods

Participants

Sixteen patients diagnosed with probable AD (McKhann *et al.*, 1984) and 16 healthy older controls were included in the study. The data from one patient were excluded due to a technical problem during testing. Demographic and clinical data are presented in Table 1. All participants gave their informed consent to participate to the study. Patients were recruited via memory clinics, and diagnosis was based on general examination, neurological and neuropsychological assessments, and positron emission tomography with [18F]fluorodeoxyglucose as biomarker of neurodegenerative disease. They were all in a mild stage of dementia (MMSE between 20 and 29, Folstein, Folstein, & McHugh, 1975). Healthy controls had no neurological or psychiatric problems, were free of medication that could affect cognitive functioning, and reported being in good health. The AD and control groups were matched in terms of age, $t(29) = -0.37$, $p = .71$, and number of years of education, $t(29) = 0.27$, $p = .79$. On the Mattis Dementia Rating Scale (Mattis, 1988), AD patients' scores ranged from 117 to 139 of 144, whereas the controls scored from 136 to 144. The patients scored poorer than the controls, $t(29) = 8.08$, $p < .001$.

Materials

The stimuli consisted of 100 French nouns, half of which used in a No-Overlap condition and the other half in an Overlap condition. The mean frequency per 100 million was 334 ($SD = 522$) for this set, corresponding to very low frequency. In the No-Overlap condition, the 50 words were made of 25 words composed of a subset of letters of the alphabet (a, c, g, i, j, l, n, q, u, t, v, w, z) and 25 words composed of the remaining letters (b, d, e, f, h, k, m, o, p, r, s, x, y). The 50 words in the Overlap condition were based on the whole alphabet. Words in this condition were randomly divided into two lists of 25 words, and each letter appeared the same number of times in both lists. The four lists (two lists in the No-Overlap condition and two lists in the Overlap condition) were matched in terms of length, lexical frequency, and phonotactic frequency (Brulex database, Content, Mousty, & Radeau, 1990). The four lists are presented in Appendix. At encoding, one list of 25 words was presented in each condition. At test, the 25 studied words were mixed with 25 non-studied words to create a yes/no recognition task. The status of the lists as target stimuli or distractor stimuli was counterbalanced across participants.

Procedure

Participants were tested individually in a quiet room. They performed both the No-Overlap and Overlap recognition tasks. The order of presentation of the conditions was rotated across participants. In each condition, the study phase involved the visual presentation of target words at a rate of one word every 1.5 s. Participants were instructed to read the words aloud and to try and remember them. After five minutes break filled with conversation, the 25 studied words were presented with 25 new words one at a time. Participants had to indicate whether the words were previously presented or not (yes/no judgments). Responses were self-paced. A delay of 24 hr separated the two conditions. After the experiment, we asked participants whether they had noticed something in the experiment. All participants were unaware of the experimental manipulation.

Statistical analysis

If fluency processing is preserved in the early stage of the disease, we expect at least a similar benefit of the No-Overlap condition compared to the Overlap condition in patients

Table 1. Demographic data and Mattis Dementia Rating Scale score

	Control	AD
Age	77.96 (6.48)	78.53 (6.15)
Sex (male:female)	5:11	5:10
Education (years)	10.06 (1.73)	9.87 (2.33)
Mattis DRS score*	141.31 (1.99)	124.73 (7.03)

Notes. AD = patients with Alzheimer's disease.
Standard deviations are in parentheses.
*$p < .001$.

with AD and healthy controls. If the optimal availability of fluency cues promotes their use in patients, one might observe smaller group differences in the No-Overlap condition compared to the Overlap condition. In contrast, if fluency processing is impaired in AD, we should observe no benefit from the experimental manipulation in AD. To test these hypotheses, we performed ANOVAs with group (AD vs. Control) as between-subject variable and condition (No-Overlap vs. Overlap) as repeated measure on the different memory scores. The proportions of hits, FA, index of discrimination (A'), and response bias (B'') (Snodgrass & Corwin, 1988) for each group and each condition are presented in Table 2.

To assess the impact of the order in which the conditions were administered on recognition performance as a function of group and condition, we conducted three-way ANOVAs with group (AD vs. Control) and order of the tasks (No-Overlap/Overlap vs. Overlap/No-Overlap) as between-subject variables and Condition (No-Overlap vs. Overlap) as repeated measure on A' scores.

Results

There was no significant main effect of order and no significant interaction involving order (all ps $>$ .08), so this variable was not included in the following analyses.

The ANOVAs on hits showed that both groups recognized more targets in the No-Overlap condition than in the Overlap condition, $F(1, 29) = 8.99$, MSE = 0.08, $p < .01$, $\eta_p^2 = .24$. Patients with AD made significantly less hits than controls, $F(1, 29) = 4.34$, MSE = 0.21, $p < .05$, $\eta_p^2 = .13$. However, the Group by Condition interaction was not significant, $F(1, 29) = 1.13$, $p = .30$. As for FA, both groups made less FA in the No-overlap condition than in the Overlap condition, $F(1, 29) = 6.02$, MSE = 0.06, $p < .05$, $\eta_p^2 = .17$. False alarms were more frequent in the AD group than in the Control group, $F(1, 29) = 37.5$, MSE = 0.90, $p < .001$, $\eta_p^2 = .56$, but there was no significant interaction, $F(1, 29) = 0.05$, $p = .82$.

An ANOVA on A' scores revealed that discrimination was poorer in the Overlap condition than in the No-Overlap condition, $F(1, 29) = 11.82$, MSE = 0.05, $p = .001$, $\eta_p^2 = .29$, and was also poorer in the AD group than in the Control group, $F(1, 29) = 33.49$, MSE = 0.33, $p < .001$, $\eta_p^2 = .54$. The Group by Condition interaction was not significant, $F(1, 29) = .001$, $p = .98$.

The ANOVA on B'' scores revealed that patients with AD had a more liberal response bias than controls, $F(1, 29) = 15.14$, MSE = 3.96, $p < .001$. There was no significant effect of the condition, $F(1, 29) = 0.10$, $p = .74$, and no Group by Condition interaction, $F(1, 29) = 0.22$, $p = .64$.

Discussion

To examine fluency-based recognition memory in AD, the current study used the paradigm developed by Parkin *et al.* (2001). In the Overlap condition, studied and unstudied items only differed in terms of whole-word fluency. By contrast, in the No-Overlap condition, studied words and distractors differed in terms of this whole-word fluency as well as of letter-level visual and phonetic fluency because they were created from two different sets of letters. This experimental manipulation increases the salience of fluency cues in the No-Overlap condition and facilitates fluency-based discrimination between old and new items. Moreover, the manipulation was applied to low-frequency

Table 2. Mean proportions of hits and false alarms, discrimination index (A'), and response bias (B'') in the No-Overlap and Overlap conditions in the AD group and the Control group

	AD				Control			
Condition	Hits	False alarms	A'	B''	Hits	False alarms	A'	B''
No-Overlap	0.72 (0.18)	0.28 (0.13)	0.81 (0.08)	−0.09 (0.31)	0.87 (0.12)	0.04 (0.05)	0.95 (0.03)	0.37 (0.62)
Overlap	0.68 (0.24)	0.35 (0.19)	0.75 (0.12)	−0.10 (0.40)	0.77 (0.12)	0.10 (0.12)	0.90 (0.08)	0.45 (0.44)

Notes. AD = patients with Alzheimer's disease.
Standard deviations are in parentheses.

words, so that the reliability and salience of fluency cues were maximized. We predicted an increase of recognition memory performance in both patients with AD and controls in the No-Overlap condition compared to the Overlap condition. Furthermore, as fluency processing becomes the default strategy used by patients with AD, due to the impairment of recollection, the experimental maximization of the opportunity to rely on relevant fluency cues should attenuate the memory deficit in the AD group (Verfaellie & Treadwell, 1993). Conversely, if patients with AD do not benefit from the optimal availability of fluency cues in the No-Overlap condition, this may suggest that some mechanisms underlying the use of fluency in the service of recognition memory are affected in AD.

The findings indicated that, despite overall impaired recognition memory performance, patients with AD appeared to benefit from the letter fluency manipulation and increased their memory performance in the No-Overlap condition compared to the Overlap condition, as healthy older adults did. Our results are thus congruent with those obtained by Bastin *et al.* (2013) but diverge from those of Algarabel *et al.*'s study (2009) where patients with AD could not use letter fluency to increase their recognition memory performance. This discrepancy in findings may arise from differences in the characteristics of the patients and/or in the nature of the stimuli. First, the patients in the two studies appear to differ in their clinical characteristics. In Algarabel *et al.*'s study (2009), the amnesic mild cognitive impairment and patients with AD presented a larger alteration of episodic memory and executive functions. Indeed, hits rates were higher in our study than theirs. Second, the lexical frequency of words was higher in their study (31.5 per million) than here (3.3 per million). As mentioned in the introduction, the use of very low-frequency words may promote the salience of fluency cues (Glanzer & Adams, 1985, 1990; Glanzer & Bowles, 1976; Glanzer *et al.*, 1993; Jacoby & Dallas, 1981). As a whole, these results replicate Bastin *et al.*'s results (2013) and suggest a relative preservation of mild AD patients' ability to use processing fluency during recognition when the cues are salient. Notably, the replication occurs with another sample of AD patients, with different sets of words and a slightly different procedure. Compared to Bastin *et al.* (2013), the study and test lists were shorter here, the time of presentation of items during encoding and the duration of the retention interval was slightly shorter and the delay between the two experimental conditions was longer here to avoid contamination between the specific strategies used in both tasks. These variants to the procedure did not seem to strongly affect the results, as both studies found improved recognition memory performance in the No-Overlap condition compared to the Overlap condition in both patients with AD and controls. These findings are interesting to the extent that some studies showed limited benefits of the use of fluency cues in memory-impaired patients. For instance, Conroy, Hopkins, and Squire (2005) showed that amnesic patients could not improve their recognition performance to the same extent as healthy controls when the level of fluency was manipulated, although this mechanism seems well preserved. More recently, Ozubko and Yonelinas (2014) even suggested that the manipulation of the level of fluency can disrupt recognition memory in amnesic patients due to the enhancement of the feeling of familiarity for unstudied items, but not for studied items.

However, the preservation of the use of fluency cues coexists with a dysfunction of other memory processes. Indeed, patients with AD did not benefit from the optimal availability of fluency cues during recognition memory in a way that would allow them to attenuate their recognition memory deficit. In particular, patients with AD produced many FA in both conditions. As suggested by Gallo *et al.* (2006), patients with AD were probably over-dependent on distorted feelings of familiarity. Indeed, for an efficient use of feelings of familiarity to recognize studied items, people must evaluate if the use of familiarity in recognition decisions is appropriate in the current context through metacognitive and post-retrieval processes. While the feeling of familiarity seems to be preserved in the early stage of AD (for reviews, see Koen & Yonelinas, 2014; Schoemaker *et al.*, 2014; Simon & Bastin, 2014), currently, some studies call into question the integrity of the metacognitive and post-retrieval monitoring processes (Besson *et al.*, 2015; Budson, Dodson, Daffner, & Schacter, 2005; Zhang & Geng, 2010) or the ability to monitor multiple sources of familiarity. A default in the monitoring of relevance of these sources of feeling of fluency, which depends on the expectations held by the subject in a particular context (Westerman, 2008; Whittlesea & Williams, 2001b), creates an illusion of familiarity characterized by an increase of FA (Diana, Peterson, & Reder, 2004; Jacoby & Whitehouse, 1989; Whittlesea, 1993) and a more liberal responses bias (Gold *et al.*, 2007; Wolk *et al.*, 2005). In the current study, patients with AD showed an increased tendency to respond 'old' across both conditions, resulting in enhanced FA to unstudied words. In the No-Overlap condition, new words carried almost no letter-level fluency and no experimentally induced word fluency. So, if patients were relying exclusively on the manipulated relative fluency cues, they should have rejected these new words. Yet, they endorsed them as old more often than did older adults. Given that these words were existing in their semantic memory, even though of low frequency, pre-experimental knowledge of the words may have induced a feeling of absolute familiarity. Because of impaired recollection and deficient metacognitive and post-retrieval monitoring processes, patients with AD were inefficient at evaluating the source of this feeling of familiarity and therefore made more FA and were more inclined to apply a liberal response bias (Budson *et al.*, 2005). Future work should examine the use of fluency cues in a similar paradigm applied to non-words. In such conditions, one may expect that patients with AD disproportionally benefit from the fact that sources of fluency are limited to letter-level and experimental word fluency.

Altogether, the current study suggests that, even if patients with AD do benefit from letter-level fluency as cues for recognition decisions, optimizing the availability of this cue is not sufficient to reduce their recognition memory deficit. The feeling of familiarity arises from multiple sources (here, fluency-based sources of familiarity (e.g., letter-level, word-level fluency), but also absolute pre-experimental familiarity) and the ability to deal with them may be compromised in AD. Actually, some aspects may be preserved in AD, such as the fluency heuristic itself, but if post-retrieval monitoring processes and metacognitive aspects are impaired early in the disease, patients may show an over-generalized feeling of familiarity that hinders accurate discrimination. The investigation of manipulations that can diminish false recognition will be an important area of future research.

In the field of cognitive rehabilitation for patients with AD, identifying areas of intact cognition is a major challenge as it can provide the basis of clinical interventions that may help patients to lead more independent lives. Despite the fact that impaired memory is the core clinical symptom of AD, studies suggest that a few aspects of memory processing remain relatively preserved. This is notably the case of fluency-based memory. Even though the current study confirms that manipulating the availability of fluency cues during a memory task has a positive impact on memory performance of patients with AD, our attempt to maximize the reliability of these cues failed to significantly attenuate the severity of the memory deficits. Further studies should investigate which conditions are the most efficient at promoting the use of fluency cues. Nevertheless, it could be that the benefit due to fluency-based processes would never be large in magnitude. There may be a natural limit to the impact of fluency-based discriminations.

Future work should use a Remember/Know paradigm during recognition decisions to assess the readiness of participants to use either familiarity or recollection in the two tasks and then to test the hypothesis of a greater use of recollection in healthy controls and an overdependence on familiarity in the AD group.

In summary, the current study attempted to create an optimal context for fluency-based recognition memory by increasing the salience and the availability of fluency cues. The results showed that patients with AD were able to increase their discrimination abilities when relative letter-level perceptual fluency between old and new words was made more salient, but this did not allow to attenuate the amplitude of their memory deficit. This may indicate that the reliance on fluency cues in AD, even though efficient, was not sufficient to compensate for the dysfunction of other memory processes (recollection, post-retrieval monitoring) that may primarily underlie their memory deficit.

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Appendix: Lists of words used in the experiment

List 1				List 2			
No-Overlap condition							
accu	\a.ky\	naja	\na.ʒa\	bébé	\be.be\	home	\om\
acquit	\a.ki\	natal	\na.tal\	bobo	\bo.bo\	hydre	\idʀ\
antan	\ã.tã\	naval	\na.val\	bohème	\bɔ.ɛm\	mémé	\me.me\
aval	\a.val\	quanta	\kã.ta\	bomber	\bɔ̃.be\	morse	\mɔʀs\
cagna	\ka.ɲa\	tain	\tɛ̃\	bombyx	\bɔ̃.biks\	myope	\mjɔp\

Continued

Appendix (*Continued*)

List 1				List 2			
câlin	\kɑ.lɛ̃\	talc	\talk\	boom	\bum\	ode	\ɔd\
canal	\ka.nal\	tanin	\ta.nɛ̃\	bore	\bɔʀ\	ombrer	\ɔ̃.bʀe\
cancan	\kã.kã\	tannant	\ta.nã\	boxe	\bɔks\	orbe	\ɔʀb\
canin	\ka.nɛ̃\	taquin	\ta.kɛ̃\	broder	\bʀɔ.de\	orme	\ɔʀm\
cantal	\kã.tal\	tic-tac	\tik.tak\	brome	\bʀom\	oxyde	\ɔk.sid\
cinglant	\sɛ̃.glã\	titan	\ti.tã\	brosser	\bʀɔ.se\	pesée	\pə.ze\
claquant	\kla.kã\	titi	\ti.ti\	broyer	\bʀwa.je\	peso	\pe.so\
clinquant	\klɛ̃.kã\	tuant	\tɥã\	derme	\dɛʀm\	poker	\pɔ.kɛʀ\
gaga	\ga.ga\	tutu	\ty.ty\	doper	\dɔ.pe\	pommé	\pɔ.me\
gagnant	\ga.ɲã\	vacant	\va.kã\	dorer	/dɔʀe/	pomper	\pɔ̃.pe\
gala	\ga.la\	vaccin	\vak.sɛ̃\	elfe	\ɛlf\	pore	/pɔʀ/
galant	\ga.lã\	vaillant	\va.jã\	éphèbe	\e.fɛb\	pose	\poz\
gang	\gãg\	vantail	\vã.taj\	épode	\e.pɔd\	probe	\pʀɔb\
gitan	\ʒi.tã\	vilain	\vi.lɛ̃\	errer	\e.ʀe\	rebord	\ʀə.bɔʀ\
glaçant	\gla.sã\	villa	\vil.la\	ferrer	\fɛ.re\	repère	\ʀə.pɛʀ\
gluant	\gly.ã\	vivat	\vi.va\	fesser	\fɛ.se\	rôder	\ʀo.de\
java	\ʒa.va\	watt	\wat\	forer	\fɔ.ʀe\	serpe	\sɛʀp\
lai	\lɛ\	vlan	\vlã\	hère	\ɛʀ\	serre	\sɛʀ\
liant	\ljã\	zigzag	\zig.zag\	herpès	\ɛʀ.pɛs\	spore	\spɔʀ\
lutin	\ly.tɛ̃\	zinnia	\zi.nja\	herse	\ɛʀs\	xérès	\kse.ʀɛs\
Overlap condition							
ascèse	\a.sɛz\	nigaud	\ni.go\	auge	\oʒ\	mitré	\mit.ʀe\
aura	\ɔ.ʀa\	ocelle	\ɔ.sɛl\	austère	\ɔs.tɛʀ\	noise	\nwaz\
brimer	\bʀi.me\	oiseux	\wa.zø\	botter	\bɔ.te\	ourson	\uʀ.sɔ̃\
calmar	\kal.maʀ\	option	\ɔp.sjɔ̃\	boudoir	\bu.dwaʀ\	pénal	\pe.nal\
chariot	\ʃa.ʀjo\	pactole	\pak.tɔl\	broche	\bʀɔʃ\	penny	\pɛ.ni\
colza	\kɔl.za\	peureux	\pœ.ʀø\	cédille	\se.dij\	pin	/pɛ̃/
crypte	\kʀipt\	pingre	\pɛ̃gʀ\	couette	\kwɛt\	ployer	\plwa.je\
cuiller	\kɥi.jɛʀ\	plasma	\plas.ma\	crispant	\kʀis.pã\	polka	\pɔl.ka\
dédit	\de.di\	poigne	\pwaɲ\	croître	\kʀwatʀ\	poussin	\pu.sɛ̃\
écru	\e.kʀy\	poney	\pɔ.nɛ\	duvet	\dy.vɛ\	rusé	\ʀy.ze\
enceinte	\ã.sɛ̃t\	prêcheur	\pʀɛ.ʃœʀ\	fécule	\fe.kyl\	sérac	\se.ʀak\
façade	\fa.sad\	réseau	\ʀe.zo\	filon	\fi.lɔ̃\	seyant	\sɛ.jã\
fauche	\foʃ\	roulure	\ʀu.lyʀ\	fouillis	\fu.ji\	teindre	\tɛ̃dʀ\
foetal	\fe.tal\	sciure	/sjyʀ/	fouler	\fu.le\	tenon	\tə.nɔ̃\
fretin	\fʀə.tɛ̃\	soja	\sɔ.ʒa\	gallon	\ga.lɔ̃\	terrier	\tɛ.ʀje\
gâteux	\gɑ.tø\	sylphe	\silf\	goder	\gɔ.de\	thorax	\tɔ.ʀaks\
glabre	\glɑbʀ\	titan[a]	\ti.tã\	guêpe	\gɛp\	thymus	\ti.mys\
guenon	\gə.nɔ̃\	trique	\tʀik\	hareng	\a.ʀã\	triche	\tʀiʃ\
jabot	\ʒa.bo\	vasque	\vask\	harpe	\aʀp\	tronquer	\tʀɔ̃.ke\
jatte	\ʒat\	verseur	\vɛʀ.sœʀ\	huileux	\ɥi.lø\	valve	\valv\
klaxon	\klak.sɔ̃\	vicieux	\vi.sjø\	infant	\ɛ̃.fã\	venger	\vã.ʒe\
lyncher	\lɛ̃.ʃe\	vigueur	\vi.gœʀ\	jauger	\ʒɔ.ʒe\	virole	\vi.ʀɔl\
machin	\ma.ʃɛ̃\	visée	\vi.ze\	judas	\ʒy.da\	vogue	\vɔg\
maffia	\ma.fja\	viveur	\vi.vœʀ\	jument	\ʒy.mã\	wallon	\wa.lɔ̃\
manquant	\mã.kã\	western	\wɛs.tɛʀn\	laquais	\la.kɛ\	zébrer	\ze.bʀe\

[a]Participants who have had the word "titan" in Overlap did not have the word "titan" in No-Overlap condition.