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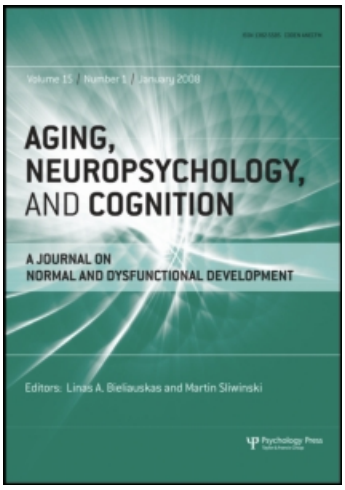

Aging, Neuropsychology, and Cognition
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713657683

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Online Publication Date: 01 March 2003

To cite this Article Moulin, Chris J. A., James, Niamh, Perfect, Timothy J. and Jones, Roy W.(2003)'Knowing What You Cannot Recognise: Further Evidence for Intact Metacognition in Alzheimer's Disease',Aging, Neuropsychology, and Cognition,10:1,74 — 82
To link to this Article: DOI: 10.1076/anec.10.1.74.13456
URL: http://dx.doi.org/10.1076/anec.10.1.74.13456

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Aging Neuropsychology and Cognition
2003, Vol. 10, No. 1, pp. 74–82

1382-5585/03/1001-074$16.00
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Knowing What You Cannot Recognise: Further Evidence for Intact Metacognition in Alzheimer's Disease

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ABSTRACT

Previous research has examined whether Alzheimer's disease (AD) patients can proficiently monitor their memory processing. In the present study we extended the scope of this research to consider confidence in recognition in an episodic memory task, using a forced-choice recognition paradigm to avoid floor effects. AD patients and age-matched controls studied 32 words, followed immediately by a recognition test requiring participants to select the target from pairs of items. Participants rated confidence in their choice on a 3-point scale. Despite significantly poorer memory performance and less confidence overall, gamma correlations indicated that the AD group accurately assigned confidence judgements to their responses. This adds support to the claim that metacognitive monitoring remains intact in AD.

Alzheimer's disease is a progressive neurological condition characterised by deficits in episodic memory. One way of demonstrating this episodic deficit is with tests of recognition, where participants have to differentiate old items (that they studied previously) from new items (that they did not study earlier). In this case, AD participants tend to correctly recognise fewer old items than controls, but also make more false positive errors (i.e., incorrectly judging a new item to be old). This combined problem of relatively low hits and high false positives is interesting, because it suggests that as well as merely forgetting previously presented stimuli, Alzheimer's disease patients also confuse new items as old. Such confusion could possibly be due to a failure to monitor the veracity of an answer at test.

Researchers aiming to explain episodic memory dysfunction have occasionally turned to a metacognitive explanation of episodic memory failure, for example, Light, 1991 (normal ageing); Shimamura and Squire, 1986 (amnesic patients); and Moulin, Perfect, and Jones, 2000a (Alzheimer's disease). Metacognition relates to the higher order control, awareness and beliefs about cognitive function. Metacognitive failure can impact on episodic memory through the failure to allocate resources during study or the failure to reject possible competitor items at test. The present study examines the episodic memory deficit in AD within a metacognitive framework, with focus on monitoring recognition memory. Memory monitoring is typically assessed by considering whether people's subjective reports of their performance relate to their objective performance. By definition, people who proficiently monitor their memory will be able to produce estimates of performance that are

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Accepted for publication: July 11, 2002.

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reflective of actual performance. (For an overview of theoretical metacognitive constructs and their empirical measures see Nelson & Narens, 1990.)

Two issues concern researchers interested in the veracity of people's assessments of their memory. One is calibration: whether people are under- or over-confident in their appraisal of memory. An individual is well calibrated if the magnitude of their judgement is in keeping with their actual performance. The other is relative accuracy – whether people can judge which items they have learnt better, or which are more likely to have been correctly remembered. Whereas calibration is concerned with absolute levels of predictions, relative accuracy considers only the relative pattern – an individual may under- or over-estimate their performance, but they can nonetheless be sensitive to the differences between items (for a discussion of relative and absolute accuracy see Connor, Dunlosky, & Hertzog, 1997). Previous research into metacognition in AD has tended to concentrate on absolute accuracy – finding that individuals are poorly calibrated, overestimating their performance (e.g., Correa, Graves, & Costa, 1996). Largely this emphasis on calibration in the literature has been driven by practical issues: people with AD have very poor memory performance, so it is difficult to compare metacognitive judgements with actual performance. As a result, it has been easier to demonstrate overconfidence: people with AD do not realise how bad their memory function is.

Experimental investigations of memory monitoring at test have primarily employed two different procedures: feeling of knowing (FOK) and confidence judgements. The FOK procedure requires participants to estimate their confidence for future recognition of items that are currently non-recallable. Confidence judgements are retrospective. Participants estimate the accuracy of their performance after they have retrieved an item from memory. In normal populations, confidence judgements tend to be accurate estimates of performance. There is a moderate relationship between participants' confidence in their answers and their memory performance. This is true of different populations, tasks and test materials (Nelson & Narens, 1990).

Bäckman and Lipinska (1993) examined both confidence and FOK accuracy for general knowledge items in Alzheimer's disease. They assessed confidence accuracy for recall, where participants assigned confidence to answers to questions such as 'Who succeeded President Nixon as the President of the United States?' They found that recall increased as a function of confidence, and that their AD participants and controls did not differ in the accuracy of their confidence judgements. This is an evidence that AD participants can accurately monitor the veracity of a recalled answer. When participants could not recall an answer, they produced a FOK, rating the probability with which they would recognise the correct answer in a subsequent test. This produced further evidence for preservation of memory monitoring in AD. The recognition accuracy of both AD participants and age matched controls increased as a function of FOK ratings, and there were no group differences. This ability of AD participants to correctly predict whether they can recognise the answer to a general knowledge test (see also Lipinska & Bäckman, 1996) has been interpreted as evidence for preserved memory monitoring – at least for general knowledge stimuli – in early AD.

The focus of the present study was episodic memory. It is unclear whether episodic memory monitoring will be proficient in AD. There is evidence in normal populations that it is distinct from general knowledge monitoring, and is less accurate (e.g., Perfect & Hollins, 1999; Schwartz & Metcalfe, 1994). It is conceivable that whereas monitoring is proficient for general knowledge in AD, it is not for episodic memory.

To our knowledge, only one study has considered episodic memory and confidence judgements in Alzheimer's disease. Pappas et al. (1992) measured confidence after recall in an episodic memory task and predictions of recognition in an FOK task. They found that AD patients had less confidence in their recall than controls. However, in both the AD and the control group correct recall increased with higher confidence. The AD group was as accurate as controls at monitoring their recall performance. For the FOK procedure, neither groups' judgements were predictive of subsequent recognition.

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Although Pappas et al.'s (1992) work suggests that people with AD are no worse than controls at memory monitoring, there are some problems with their study. Firstly, it could be criticised for the possible introduction of bias in confidence judgements. During the recall phase, participants were prompted to give their "best guess" if they had not recalled an item within 30 s. The low level of recall in the AD group (only 22% of control performance) was presumably characterised by a high proportion of answers where they had been instructed to guess. Therefore, an instruction to guess was followed immediately with the participant assigning confidence in their answer. This procedure may have guided their confidence, causing the high amount of *guess* responses and the metacognitive accuracy. Secondly, their study had floor effects, which are characteristic of studies that use recall as a measure in AD. Recall is often so low as to preclude the use of statistical evaluations of confidence-accuracy relationships, or based on so few participants as to decrease the generalisability of the study. For example, in Pappas et al.'s study, the assessment of accuracy was limited to a subset of 7 AD patients because of floor effects. Because these participants were those who had higher recall, we might expect that they were a set of higher achieving individuals, who may give a poorer reflection of general memory monitoring abilities in people with AD. Indeed, there were strong correlations between recall performance and monitoring accuracy in this sample of 7 people. Likewise, Bäckman and Lipinska acknowledge that their recall confidence measures are based on relatively few observations in the AD sample because of floor effects.

Our previous research has considered episodic memory monitoring in AD, but with focus on processes occurring during study, not test. We used sensitivity measures (e.g., Moulin et al., 2000a), an approach that assesses whether judgements of performance are in keeping with the known properties of the stimuli and encoding conditions, and thus avoid problems associated with floor effects. Because this work shows that assessments of performance in the AD group are as appropriate as controls, we have argued for intact memory monitoring in AD in episodic memory, a conclusion that is in keeping with some of the previous research into metacognition in AD.

In summary, some previous research has indicated that memory monitoring is proficient at test in AD. However, this evidence is largely based on research on general knowledge; with confidence in recall and with episodic memory in particular, research is confounded by floor effects. In the present experiment we examined confidence for forced-choice recognition. Both Bäckman and Lipinska's (1993) and Pappas et al.'s (1992) work shows that recognition performance is comparatively better than recall in the AD group. The use of a forced-choice recognition test ensured that performance was above floor for all participants and therefore enabled the use of gamma correlations to investigate relative accuracy. The aim was to assess memory monitoring at test for episodic stimuli. In line with findings from previous memory monitoring studies, we expected that AD patients would be able to assess the veracity of their responses at test.

METHOD

Participants

There were 32 participants. Sixteen were patients with a diagnosis of probable AD and 16 were older adult controls (OAC) who had volunteered to take part in the study. Diagnosis was made by independent clinicians on the basis of information gathered from neuropsychological examination (the Cognitive Profile; Hooper & Bucks, 1993), based on the CAMDEX assessment tool (Roth et al., 1986), Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), family interview, laboratory screening (i.e., hematology; B12 and folate levels; renal, liver and thyroid function; calcium and syphilis serology), and medical examination. Patients were diagnosed as being demented with the DSM-III–R criteria (American Psychiatric Association, 1987) and as having probable AD by the NINCDS-ADRDA criteria (McKhann et al., 1984). The AD and control group were not significantly different ($F < 1$) in age or level of education (AD mean age 74.38 (9.86); OAC mean age 74.22 (4.57); AD mean level of education (years) 11.50 (2.58); OAC mean 10.28 (2.03)). The AD group had a mean MMSE score of 17.06 (5.27). The OAC group were screened for dementia using the MMSE. They reported that they were not experiencing any health problems and had no evidence of cognitive dysfunction.

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Materials/Stimuli

Thirty-two (see Appendix) target words were selected. The targets were either common words (8 items); rare words (8 items); both drawn from Gilhooly and Logie (1980) or typical category exemplars (16 items) drawn from Battig and Montague (1969). At test these target words were presented with one distracter word. Because we wanted to ensure a range of performance and confidence judgements across the items, we varied the difficulty of the pairs at test. This was done by manipulating the relationship between the target and the distracter. Pairs that were designed to be more difficult had the target paired with a semantically related distracter (e.g., red-blue, doctor-lawyer). The pairs that were designed to be easier comprised two unrelated words, one of which was common, the other of which was rare (e.g., bayonet-aunt, microbe-chair). There were equal numbers of these two test pair types, and within the unrelated pairs, there were equal numbers of common and rare word targets.

Procedure

Participants were tested individually. Participants were not initially instructed that this was a memory experiment, but were asked to read each target word in turn. Participants were introduced to the stimuli with an example. Targets were presented in a random order and were displayed to the participant individually on a flash card until the participant had read the word. In this way, presentation advanced at a rate dictated by the participant, but there was no special instruction to memorise the items. Immediately after presentation of the 32 words, participants were administered the test phase. In this phase participants were visually administered test pairs in the same pseudo-random order from a test booklet. Participants were instructed to select the word that they had seen before from the new word. This could be done either visually (by pointing) or verbally, and the experimenter recorded the participants' responses. They were introduced to this procedure with a previously studied example. After selecting the word they thought to be the target in each pair they were presented with a 3-point scale (i.e., certain, quite sure or guessing) and instructed to rate how confident they were that they had selected the correct answer from the pair.

RESULTS

Memory Performance

Memory performance was measured by calculating the proportion correct for each participant. There was a significant difference between the two groups' memory performance, $F(1, 30) = 57.02$, $MSE = 0.01$, $p < .001$. The mean (and standard deviation) proportion correctly recognised was 0.65 (0.13) in the AD group and 0.92 (0.07) in the OAC group. One sample t tests ascertained that the mean proportion correctly recognised was significantly above 0.5 (chance) for both groups, AD $t(15) = 4.72$, $p < .001$; OAC $t(15) = 26.70$, $p < .001$.

Metamemory

Confidence Level

Confidence is assessed by considering the mean number of responses in each category, regardless of whether the response is correct. The mean responses made in the guess, quite sure and certain categories respectively were AD: 13.87 (10.40), 12.43 (8.32), 5.50 (4.11); OAC 3.87 (3.61), 6.81 (6.26), 21.31 (9.05). One-way ANOVAs assessed the mean number of responses made in each category. These demonstrated that the AD group made significantly more guess, $F(1, 30) = 13.21$, $MSE = 60.58$, $p = .001$, and quite sure $F(1, 30) = 4.67$, $MSE = 54.21$, $p < .05$, responses than the OAC group, and far fewer certain responses, $F(1, 30) = 40.51$, $MSE = 49.38$, $p < .001$. This analysis demonstrates that the AD group is less confident in their memory performance than the control group. Coupled with the fact that their memory performance is worse than controls, this suggests that they are appropriately aware of their poor performance.

Confidence Accuracy

We considered relative accuracy: whether participants correctly recognise more of the items they are more confident of than those items that they are less confident about. One way to assess this is by plotting the recognition performance for each response type. Figure 1 clearly shows that although the AD group has lower memory performance overall, they nonetheless correctly recognise more of the certain items, and less of the guessed responses. To analyse confidence accuracy we calculated a gamma correlation for each participant. This is a non-parametric measure of association between people's confidence response, and their recognition accuracy (see

Fig. 1. Proportion of responses correctly recognised for each level of confidence, Alzheimer's disease patients (AD) and older adult controls (OAC). Error bars = 1 Standard Error.

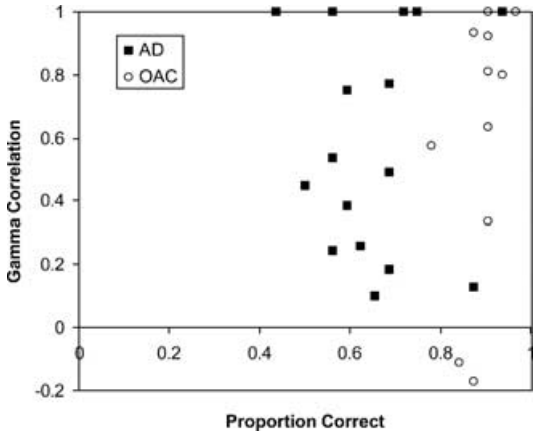

Fig. 2. Graph to show relationship between memory performance (proportion correct) and memory monitoring accuracy (gamma correlation).

Nelson, 1984). This statistic is ideal for our purposes because it measures the relative accuracy independently of the magnitude of people's confidence judgements. A gamma correlation closer to one indicates accurate memory monitoring, where an individual correctly recognises more items of which they were more certain. A gamma correlation of zero indicates no association between confidence and recognition performance. We could not compute a gamma for 4 OAC participants (who did not miss any targets) so the analysis of accuracy was confined to 12 in the control group. The mean (and standard deviation) gamma correlations for the AD and OAC groups respectively were 0.58 (0.34) and 0.64 (0.42). A one-way ANOVA showed that there was no significant difference between these values ($F < 1$). The high magnitude of these mean correlations indicates that both groups are accurate at assigning confidence to their recognition performance and the lack of a group difference suggests that the AD participants are as accurate as controls in assigning confidence to their recognition performance.

Previous researchers have often reported the relationship between actual memory performance and gamma in an attempt to address whether proficient memory monitoring is associated with better memory performance. Figure 2 shows a plot of the gamma correlation value against proportion correct for each participant. For recall gamma, Pappas et al. (1992) found a significant association between recall and confidence accuracy in the AD and OAC groups (AD: $r(7) = 0.65$, OAC $r(12) = 0.56$). This correlation was such that the people who recalled more items were more accurate in their confidence judgements, and supported the notion that a metamemory deficit may exacerbate memory impairment. However, in the present experiment using Pearson's bivariate correlations we found no such association between memory performance and gamma in the AD group, $r(16) = 0.02$. However, this relationship approached significance in the OAC group, $r(12) = 0.51$, $p = 0.09$. The sample size used in these studies is small and so these correlations should be interpreted with caution, but taken at face value they suggest that in the AD group memory impairment is not associated with reduced memory monitoring abilities at test.

DISCUSSION

Overall, the results of this experiment demonstrate that there is no deficit in Alzheimer's disease in assigning confidence levels to a forced-choice recognition test of episodic memory. These results support Pappas et al.'s (1992) findings with a recognition paradigm suggesting that their findings are not due to the instructions to participants or the very low level of recall performance in the AD group. The present study shows that although the AD group are on the whole less confident than the OAC group, they

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can nonetheless rate their confidence as being *certain* when that is appropriate.

We have demonstrated that the AD group as a whole does not show a metamemory deficit and that there is no relationship between recognition performance and monitoring abilities. Therefore, as measured by post-test confidence in recognition, it seems unlikely that a memory monitoring deficit contributes to the poor recognition memory performance in AD. This is supported by other research into different aspects of memory monitoring. Equivalence has been shown between AD groups and controls for feeling of knowing judgements for general knowledge materials (Bäckman & Lipinska, 1993; Lipinska & Bäckman, 1996), pre-study and post-study predictions of to-be-recalled lists (Moulin et al., 2000b), sensitivity to objective recallability during study of to-be-recalled items (Moulin et al., 2000a), and confidence in recall from general knowledge and episodic memory (Pappas et al., 1992). Thus, the present work adds to the increasing evidence that although Alzheimer's patients may be less able to discriminate old items from new, they can at least be sure of the veracity of their responses. Because of memory impairment, Alzheimer's patients may be forced to guess on memory tasks such as reported here; but they know that they are guessing.

For evidence that there is a memory monitoring impairment in AD, one has to turn to studies which examine generalised beliefs about memory that are not based on feedback from study or test performance (monitoring per se) but on expectations of performance. For example, several studies suggest that AD participants consistently overestimate performance on a memory test, when asked to predict how many items they will recall from a list before they study it (e.g., McGlynn & Kaszniak, 1991; Schacter, McLachlan, Moscovitch, & Tulving, 1986). Additionally, AD patients do not report any more memory decline than aged matched controls (Correa et al., 1996). An important consideration is that such studies are interested in whether people's judgements are calibrated to their actual recall (absolute accuracy). In item-based studies that report gamma correlations, the focus is upon the relative accuracy of people's judgements: whether participants can monitor which information is well learnt or correctly retrieved. (For a discussion of absolute and relative accuracy see Connor et al., 1997.) Therefore, it would appear that although AD patients may be poorly calibrated, the present work suggests that they are nonetheless monitoring their memory processes – they are capable of making relative judgements, and discriminating between items at test. This resonates with our findings for list predictions (e.g., Moulin et al., 2000b). Before an opportunity to study, people with AD predict recall at inaccurately high levels. Despite still being over-confident after study, people with AD revise their estimates to more realistic levels. That is, despite being poorly calibrated, people with AD are sensitive to the relative patterns in their memory processing.

With post-test judgements like those used in the present study, it appears that AD patients are not over-confident about their memory performance: they are appropriately aware that they are guessing. (However, some studies show that for post-test estimates of performance for whole lists of items, AD patients still overestimate performance on a list (Correa et al., 1996; McGlynn & Kaszniak, 1991).) An explanation of the propensity to over-estimate memory performance in AD is that the patient fails to update their expectations of appropriate performance. For example, AD patients predict memory performance at a level commensurate both with a control group's predictions and 50% of maximum performance (Moulin, in press). Because this suggests AD participants approach a memory test with unrealistic expectations, it is conceivable that they do not allocate resources during encoding appropriately, at least before they have experienced the memory task. Thus, further research into memory monitoring in AD should focus on monitoring before and during encoding, to gauge its impact on memory processing. Because we presented AD participants with word pairs with marked differences in relationships between items in the pair, it might also be of interest to vary the association between items to see if that influences people's confidence judgements, since AD participants may only be making metacognitive evaluations based on a consideration of the stimulus itself rather than its registration in memory.

The focus of the present work was monitoring at test. The results suggest that when presented with an episodic memory task on-line, AD patients can make an assessment of their performance that is reflective of memory performance. In conclusion, it seems unlikely that a failure of memory monitoring at test contributes to the memory impairment in AD.

ACKNOWLEDGEMENTS

The authors would like to thank the staff and patients of the RICE Memory Clinic (Research Institute for the Care of the Elderly, St. Martin's Hospital, Bath, UK). This work was supported by an ESRC scholarship award to the first author. Parts of this research were presented at the Cognitive Aging Conference (Atlanta, USA, 1998). We are very grateful for the helpful comments provided by an anonymous reviewer.

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REFERENCES

American Psychiatric Association. (1987). Diagnostic and statistical manual of mental disorders (Rev. 3rd ed.). Washington, DC: Author.

Bäckman, L., & Lipinska, B. (1993). Monitoring of general knowledge: Evidence for preservation in early Alzheimer's disease. *Neuropsychologia*, *31*, 335–345.

Battig, W.F., & Montague, W.E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monographs*, *80*, 1–46.

Connor, L.T., Dunlosky, J., & Hertzog, C. (1997). Age-related differences in absolute but not relative metamemory accuracy. *Psychology and Aging*, *12*, 50–71.

Correa, D.D., Graves, R.E., & Costa, L. (1996). Awareness of memory deficit in Alzheimer's disease patients and memory impaired older adults. *Aging, Neuropsychology and Cognition*, *3*, 215–228.

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

Gilhooly, K.J., & Logie, R.H. (1980). Age-of acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. *Behaviour Research Methods and Instrumentation*, *12*, 395–427.

Hooper, J., & Bucks, R.S. (1993). *Development of a Cognitive Assessment Profile Based on the CAMCOG Cognitive Assessment and Neurological Screening Workshop*. Paper presented to the British Psychological Society Special Interest Group in the Elderly.

Light, L.L. (1991). Memory and aging: Four hypotheses in search of data. *Annual Review of Psychology*, *42*, 333–376.

Lipinska, B., & Bäckman, L. (1996). Feeling of knowing in fact retrieval: Further evidence for preservation in early Alzheimer's disease. *Journal of the International Neuropsychological Society*, *2*, 350–358.

McGlynn, S.M., & Kaszniak, A.W. (1991). When metacognition fails: Impaired awareness of deficit in Alzheimer's disease. *Journal of Cognitive Neuroscience*, *3*, 183–189.

McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D.L., & Stadlan, E.M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's disease. *Neurology*, *34*, 939–944.

Moulin, C.J.A. (in press). Sense and sensitivity: Metacognition in Alzheimer's disease. In T.J. Perfect & B.L. Schwartz (Eds.), *Applied Metacognition*. Cambridge, UK: Cambridge University Press.

Moulin, C.J.A., Perfect, T.J., & Jones, R.W. (2000a). Evidence for intact memory monitoring in Alzheimer's disease: Metamemory sensitivity at encoding. *Neuropsychologia*, *38*, 1242–1250.

Moulin, C.J.A., Perfect, T.J., & Jones, R.W. (2000b). Global predictions of memory in Alzheimer's disease: Evidence for preserved metamemory monitoring. *Aging, Neuropsychology and Cognition*, *7*, 230–244.

Nelson, T.O. (1984). A comparison of current measures of feeling-of-knowing predictions. *Psychological Bulletin*, *95*, 109–133.

Nelson, T.O., & Narens, L. (1990). Metamemory: A theoretical framework and some new findings. In G.H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 26, pp. 125–173). San Diego, USA: Academic Press.

Pappas, B.A., Sunderland, T., Weingartner, H.M., Vitiello, B., Martinson, H., & Putnam, K. (1992). Alzheimer's disease and feeling of knowing for knowledge and episodic memory. *Journal of Gerontology: Psychological Sciences*, *47*, 159–164.

Perfect, T.J., & Hollins, T.S. (1999). Feeling of knowing judgements do not predict subsequent recognition performance for eyewitness memory. *Journal of Experimental Psychology – Applied*, *5*, 250–264.

Roth, M., Tym, E., Mountjoy, C.Q., Huppert, F.A., Hendrie, H., Verma, S., & Goddard, R. (1986). CAMDEX: A standardised instrument for the diagnosis of mental disorder in the elderly with special reference to the early detection of dementia. *British Journal of Psychiatry*, *149*, 698–709.

Schacter, D.L., McLachlan, D.R., Moscovitch, M., & Tulving, E. (1986). Monitoring of recall performance by memory disorders patients. *Journal of Clinical and Experimental Neuropsychology*, *8*, 130.

Schwartz, B.L., & Metcalfe, J. (1994). Methodological Problems and Pitfalls in the study of human metacognition. In J. Metcalfe & A.P. Shimamura, (Eds.), *Metacognition: Knowing about knowing*. London: MIT Press.

Shimamura, A.P., & Squire, L.R. (1986). Memory and metamemory: A study of feeling-of-knowing phenomenon in amnesic patients. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *12*, 452–460.

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APPENDIX

Stimuli used in this experiment

The forced-choice pairs are shown below. The target word is underlined.
U = Unrelated pairs, R = Related pairs

wharf – car [U]
robin – sparrow [R]
lynx – football [U]
sweater – shirt [R]
milk – smut [U]
mountain – cave [R]
abode – carrot [U]
piano – oboe [R]
tornado – hurricane [R]
ruby – diamond [R]
bayonet – aunt [U]
priest – minister [R]
salt – oregano [R]
urchin – church [U]
microbe – chair [U]
stanza – house [U]
doll – yew [U]
apple – monocle [U]
legs – rhapsody [U]
metre – mile [R]
booth – cotton [U]
lieutenant – general [R]
gauntlet – window [U]
iron – lead [R]
red – blue [R]
hour – millisecond [R]
dog – mouse [R]
cyst – oil [U]
algae – magazine [U]
mixer – knife [R]
doctor – lawyer [R]
chilli – hammer [U]

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