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## Metacognition and attribution of difficulty for self and others in Alzheimer's disease

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### Abstract

A common feature of Alzheimer's disease (AD) is lack of awareness of neuropsychological deficit or illness, including poor appreciation of impaired task performance. Nevertheless, it has been shown in different clinical groups that levels of awareness may vary according to whether appraisal of symptoms is made in a first-or third-person perspective. This study explored this issue further in two experiments in which people with AD and control participants completed tests of memory and reaction time and had to judge both how difficult the tasks were for them and also for other people if they attempted the same tasks. Results showed that the AD group systematically indicated that others would do as well as they themselves had done. In comparison, control participants indicated other people would perform worse than they did themselves on the reaction time tasks, but similarly on the memory tasks. In addition, attribution of difficulty for self/other correlated with pre-morbid personality traits, such as neuroticism and agreeableness, in the AD group. The theoretical and clinical implications of these findings are discussed.

**Keywords:** dementia, anosognosia, awareness, metacognition, perspective taking, success-failure manipulation, pre-morbid personality.

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### Introduction

People with Alzheimer's disease (AD) frequently experience reduced awareness of their everyday cognitive deficits, their performance on neuropsychological tests and also show lack of understanding of their own illness (Morris & Hannesdottir, 2004; Mograbi, Brown, Salas & Morris, 2012; Morris & Mograbi, 2013). These phenomena, which have underlying neurobiological causation but may be modulated by psychological factors, have important clinical implications, affecting the ability of patients to seek and comply with treatment (Patel & Prince, 2001), impacting patient safety (Starkstein, Jorge, Mizrahi, Adrian & Robinson, 2007) and contributing to caregiver burden (Seltzer, 1997).

One important feature of unawareness in AD is impaired ability to monitor performance during cognitive testing. In this regard, metamemory research has shown that in AD there is reduced awareness of

performance during memory tasks, with frequent overestimation of abilities (for a review, see Souchay, 2007). In addition, deficits in estimation of performance have been shown using a number of different paradigms and cognitive tasks (e.g., Agnew & Morris, 1998; Clare, 2002; Hannesdottir & Morris, 2007, Mograbi et al., 2012). This deficit in error monitoring and metacognitive ability may have a considerable impact on how an individual adapts to difficulties and performs activities of daily living (Bettcher, Giovannetti, Macmullen & Libon, 2008; Giovannetti, Libon & Hart, 2002).

It has also been shown in different clinical groups that awareness can vary according to whether appraisal is done in a first-or third-person perspective. For example, in the context of anosognosia for hemiplegia, patients may acknowledge the paralysis of others while insisting they themselves can move normally (Ramachandran & Rogers-Ramachandran, 1996). This echoes clinical observations in dementia in which there may be unawareness of deficits but the person may comment on and acknowledge the symptoms of other people with dementia. In a similar manner, a recent study has shown that in response to clinical vignettes involving descriptions of early-stage dementia, the participants showed the ability to correctly identify the problems depicted and offer appropriate advice (Clare et al., 2012). Some people with dementia also spontaneously recognised their own condition and difficulties when

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reading the vignettes (Clare *et al.*, 2012). Finally, there is some evidence that improvement in awareness into symptoms can be achieved through video self-observation, something which has been observed in the case of anosognosia for hemiplegia (Fotopoulou, Rudd, Holmes & Kopelman, 2009) and psychosis (Davidoff, Forester, Ghaemi & Bodkin, 1988; McEvoy, Schooler, Friedman, Steingard & Allen, 1993; Startup, 1997; Vickram, Yarger, Coxell & Maier, 2008).

Although acknowledging deficits in others but not self may be related to the operation of self-serving biases in cognition (Kahneman & Tversky, 1972), it is also likely that this dissociation reflects the existence of different neural networks involved in self/other appraisal. This notion is included in current models of awareness in AD (Morris & Mograbi, 2013), which propose dissociated memory records for self/other efficacy. According to this perspective, there is a Generic Memory System composed of general semantic knowledge, which can be used as the basis for evaluating ability in others. In contrast, information about self-efficacy would rely on an Autobiographical Memory System and Personal Data Base, based on personal semantics and incident memory. This is consistent with evidence that trait self-knowledge is functionally independent from semantic world knowledge (Klein, Cosmides, Costabile & Mei, 2002).

One factor that might be related with different estimations of ability for first- and third-person perspectives in people with dementia is pre-morbid personality. Personality factors have been linked to attributional style (Weiner, 1986) and there is some evidence for the influence of pre-morbid personality on awareness in people with dementia. Studying this clinical group, Seiffer and associates (2005) found reduced awareness associated with increased conscientiousness, the latter measured by a standardised personality inventory. Nevertheless, these findings have not been replicated in a recent study by Gilleen and colleagues (2012) who did not find any association between awareness using a similar measure of pre-morbid personality.

In summary, there is preliminary evidence suggesting that people with AD might show better awareness when evaluating abilities of others or themselves in a third-person perspective, but this issue has not been explored experimentally beyond the vignette study technique. Accordingly, we explored this issue further as part of two experiments in which people with AD completed tests of memory and reaction time, requiring them to judge difficulty levels for 'self' and 'other'. This follows from a previous paper in which emotional reactivity to success or failure on these tests was reported, comparing this to levels of awareness concerning self-performance (Mograbi *et al.*, 2012). Here we present additional data in which we also asked people to judge how difficult the task was for them and would be for someone else their own age. On the tasks used, performance has been carefully titrated by varying the difficulty levels for

each person so as to equate the difficulty levels between participants and groups. Hence, this procedure provided a means to more realistically compare 'self' versus 'other' judgements of performance, given the equated performance levels. We hypothesised that people with AD would have more realistic predictions for others than for themselves, in line with previous findings on perspective taking and awareness in AD. Moreover, data concerning pre-morbid personality are also presented in this study because of the possibility that personality characteristics could influence attributions of performance including confidence concerning ability when comparing 'self' versus 'other' judgements. In particular, we predicted that dimensions such as conscientiousness and neuroticism would be linked to 'self'/'other' comparisons.

## Methods

### *Participants*

Twenty one participants with mild to moderate AD were included in the study, recruited either from the South London and Maudsley/Institute of Psychiatry Biomedical Research Centre (BRC) Dementia Case Register or from the St George's Healthcare NHS Trust (London) Dementia clinic. Diagnosis was made using DSM-IV criteria for Dementia of the Alzheimer's type (American Psychiatric Association, 2000), with Mini-Mental State Examination (MMSE; Folstein *et al.*, 1975) scores of 18 or above (Mungas, 91; NICE, 2006). Consecutive patients who fulfilled the study eligibility criteria were approached. Twenty one control participants were recruited from the same general area as members of the AD group, screened for cognitive impairment and abnormal memory loss using the MMSE and CERAD (Morris *et al.*, 1989) word list tests.

Both groups were aged 65 years or more. Exclusion criteria were no current neurological disorder (other than AD in the patient group, also excluding cases with mixed AD and vascular dementia); history of head injury resulting in loss of consciousness for more than an hour; history of alcohol or substance abuse (based on ICD-10 criteria); and history of diagnosed major psychiatric illness or current comorbidity (for example, mood disorder).

The two groups were matched on age, years of education and gender ratio (see Table 1). MMSE scores and CERAD memory test measures were significantly lower for the AD patients.

### *Procedures*

Two success-failure manipulation (SFM) computerised paradigms were used (Mograbi, Brown, Salas & Morris, 2012; for a full account of the development of the tasks, see Mograbi, Brown, Brand & Morris, *in press*), one involving testing reaction time and the other memory, each having two parallel

**Table 1.** Background variables divided by group

Variable	AD group (n=21) Mean (SD)/Range	Control group (n=21) Mean (SD)/Range	p-value
Age	79.7 (6.6)/66–89	78.6 (6.6)/69–90	.576
Gender*	12/9	15/6	.334
Years of education	11.3 (3.2)/4–18	12.0 (3.3)/6–18	.448
MMSE	23.2 (3.1)/18–29	28.5 (1.3)/26–30	<.001
CERAD Immediate recall	11.3 (4.1)/2–19	21.6 (3.8)/13–28	<.001
CERAD Delayed recall	1.4 (1.3)/0–4	7.3 (1.5)/4–20	<.001
CERAD Recognition	15.6 (3.2)/9–20	19.7 (0.6)/18–20	<.001
CERAD # of Intrusions	1.9 (1.7)/0–6	0.5(0.9)/0–3	.002

\* # female/male; Analysis of differences in the gender variable using chi-square test; other analyses using t-tests.

versions made distinctive by non-essential task features (see descriptions below). The ability of the participant was first established individually by systematically increasing difficulty levels until consistent failure occurred (titration phase). The success or failure conditions were established by setting the difficulty level either above or below this performance threshold (experimental phase). Participants were not informed that levels of difficulty would be manipulated. In each experiment, one version was assigned to failure (performance levels at around 30%) and another to success (performance levels at around 80%).

The order of experiments and conditions was quasi-counterbalanced among the participants, according to the following factors: Experiment 1 (reaction time) or Experiment 2 (memory) first; success or failure condition first in each experiment; and version allocated for success or failure, in each experiment. Counterbalancing was constrained by not allowing two success or failure conditions in a row. In total this created 16 combinations and each participant was assigned a combination at random without replacement for the overall set, starting again with the next set of combinations for the remaining participants.

### EXPERIMENT 1 – REACTION TIME

In version 1 there was a warning tone and after 164 ms a car appeared on the screen moving across the screen from left to right, with the participants having to 'stop' the car as soon as it appeared by pressing a single centrally located box housed button. If pressed in time, a 'traffic warden' appears and there is a 'clink' noise. In version 2 after the same warning tone, objects (e.g. ball, egg or vase) appeared to fall from the 'top' of a building and participants had to 'catch' the object by pressing the button, success signified by a 'hand' appearing and the same 'clink' noise. In both cases a buzzer signalled failure to respond in time. Participants were told not to press the button before they saw the target or between trials. Difficulty overall was manipulated by varying the object's speed, quantified by pixels moved per screen refresh, from 12 (slowest) to 42 (fastest).

### EXPERIMENT 2 – MEMORY

The procedures were based around memory span tests. For version 1, between 1 and 10 identical everyday objects (taken from a set of photographs; e.g. alarm clocks and baskets) were displayed scattered across the screen. For each trial the objects were highlighted in a random sequence using a red square surround and immediately after participants had to point to the same objects in sequence. For version 2, participants had to listen to a sequence of digits ranging from 0 to 9, also presented individually visually in the centre of the screen, and immediately repeat it back sequentially to the experimenter. For both versions, completely correct responses were indicated by a green visual 'tick' and an auditory 'clink', and failure by a red cross and a buzzer. The shortest sequence was one and the longest ten objects/digits.

### Measures

#### *Awareness of performance*

An Objective-Judgement Discrepancy (OJD; Agnew & Morris, 1998) method was used in which immediately after the success or failure conditions, participants were asked to rate how well they did, with ratings compared to actual performance. Because there was no apparent discontinuity to participants between titration and experimental phases in each task, performance was considered over the whole task (excluding the practice trials). Ratings were done using a 0% to 100% scale, with 0% meaning all trials were wrong and 100% all trials correct. The OJD score was obtained subtracting actual performance (expressed in terms of % correct) from estimation of performance, with positive scores indicating overestimation of performance.

#### *Perspective taking and attributional style*

In addition to the question about performance, the perceived difficulty of the tests was also measured. After each task, participants were asked: "How difficult this task was, from 0 to 100?" After that, participants were then asked: "How difficult this task would be for most people of your age, from 0 to 100?"; if participants could

not think of a specific person, the experimenter would provide examples (e.g., the caregiver, relatives). By asking these two questions it was possible to measure not only attribution of task performance (e.g., participants could perform badly but suggest this was down to task difficulty) but also perspective taking (how well participants thought others would do). In addition, the 'self' difficulty score was subtracted from the 'other' difficulty, creating a summary measure for correlational analysis (below).

### ***Pre-morbid personality***

Pre-morbid personality was measured with the NEO-FFI (Costa & McRae, 1992), a 60 item questionnaire measuring the personality domains of neuroticism, extraversion, openness, conscientiousness and agreeableness. The questions were asked to informants who had to consider the patients' pre-morbid personality. The NEO-FFI has established validity and reliability (Costa & McRae, 1992) and there is evidence that it can be used reliably to measure pre-morbid personality in AD (Archer *et al.*, 2006).

### ***Ethical issues***

All participants provided informed consent. In the case of the AD group, the caregivers also gave their agreement for the patient to participate. The project was approved by the South London and Maudsley/Institute of Psychiatry Ethics Committee (Research Ethics Committee number 08/H0807/6).

### ***Statistical analysis***

In each experiment, differences in awareness of performance (OJD score) were explored with 2x2 mixed-model ANOVAs, with group (AD/Control) as a between-subject factor and condition (success/failure) as a within-subject factor. Differences in perceived difficulty were explored with 2x2x2 mixed-model ANOVAs, with group (AD/Control) as a between-subject factor and condition (success/failure) and perspective (self/other) as within-subject factors. Planned pair-wise comparisons followed significant interactions and main effects.

In addition to the main ANOVA analyses, Pearson correlations were used to explore the relationship between internal/external attribution and pre-morbid personality. In this analysis, a summary score was used, calculated as the difference between estimations of difficulty for 'self' vs. 'other'. To account for the effect of multiple testing, p-values were adjusted by Bonferroni-Hochberg corrections (Hochberg, 1988) within each experiment.

## **Results**

### ***Experiment 1 – Reaction time***

#### *Awareness of performance*

Table 2 shows that the two groups were matched on their performance in both conditions as expected from

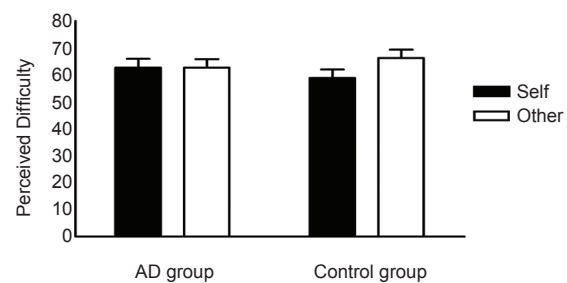
**Table 2** – Performance and awareness of performance (OJD) during Experiment 1 (reaction time) for success and failure conditions

	AD group Mean (SD)	Control group Mean (SD)
Success condition		
Estimation (%)	57.3 (15.9)	73.4 (14.4)
Performance (%)	78.9 (7.2)	79.7 (4.5)
OJD (%)	-21.6 (14.8)	-6.3 (13.9)
Failure condition		
Estimation (%)	41.9 (21.6)	27.7 (14.0)
Performance (%)	28.6 (10.5)	27.2 (6.7)
OJD (%)	13.3 (21.4)	-0.5 (13.9)

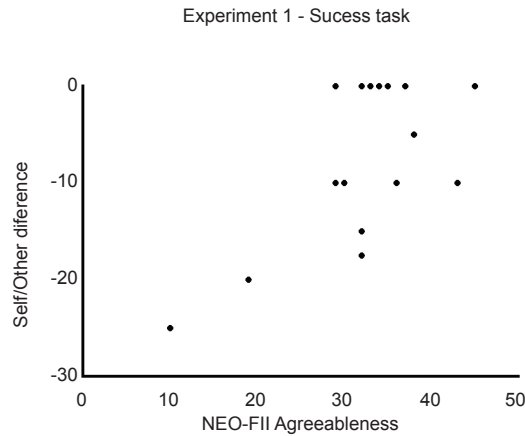
the individualised manipulation of task difficulty (see also Mograbi *et al.* 2012). Results for the OJD measure indicated a significant interaction between condition and group ( $F(1, 40) = 20.51, p < .001$ ), a main effect of condition ( $F(1, 40) = 44.80, p < .001$ ), but no main effects of group ( $F(1, 40) = 0.09, p = .754$ ). Planned comparisons indicated that the AD patients ( $p < .001$ ), but not controls ( $p = .134$ ), exhibited a difference in OJD between conditions (Table 2). The main effect of condition indicated more negative evaluation for performance after failure (Table 2).

#### *Perspective taking*

The ANOVA showed no significant condition x group x perspective interaction ( $F(1, 40) = 0.01, p = .981$ ), condition x group interaction ( $F(1, 40) = 0.39, p = .538$ ) or group main effect ( $F(1, 40) = 0.01, p = .960$ ), but a significant group x perspective interaction ( $F(1, 40) = 5.09, p = .030$ ), condition x perspective interaction ( $F(1, 40) = 7.67, p = .008$ ) and main effects of condition ( $F(1, 40) = 28.06, p < .001$ ) and perspective ( $F(1, 40) = 5.09, p = .030$ ). Planned comparisons following the group x perspective interaction indicated that controls ( $p = .003$ ), but not AD patients ( $p = .999$ ), exhibited a difference between self and other perspective (Figure 1). The condition x perspective interaction indicated lower attribution of difficulty for self vs. other for success ( $p = .002$ ), but



**Figure 1** – Perceived difficulty for self and others during Experiment 1.



**Figure 2** – Association between pre-morbid personality and perspective taking during success in Experiment 1.

no significant differences for failure ( $p = .877$ ). The main effect of condition showed higher attribution of difficulty for failure relative to success.

*Associations between perspective taking and pre-morbid personality*

There was a significant correlation between the perspective taking summary score for the success task and agreeableness ( $r = .63, p = .045$ ; Figure 2), but other results were not significant.

**Experiment 2 – Memory**

*Task performance and awareness of performance*

The groups were matched in terms of their performance (Table 3; see also Mograbi et al. 2012). Results for the OJD measure indicated a significant interaction between condition and group ( $F(1, 40) = 5.34, p = .026$ ), but no main effects of condition ( $F(1, 40) = 3.30, p = .077$ ) or group ( $F(1, 40) = 0.08, p = .769$ ). Planned comparisons indicated that patients ( $p = .006$ ), but not controls ( $p = .730$ ), exhibited a difference in OJD between conditions (Table 3). The main effect

**Table 3** – Performance and awareness of performance (OJD) during Experiment 2 (memory) for success and failure conditions

	AD group Mean (SD)	Control group Mean (SD)
<b>Success condition</b>		
Estimation (%)	60.4 (16.9)	68.1 (14.4)
Performance (%)	77.6 (8.0)	78.5 (7.5)
OJD (%)	-17.2 (14.8)	-10.4 (12.7)
<b>Failure condition</b>		
Estimation (%)	31.7 (18.0)	23.9 (17.9)
Performance (%)	34.8 (7.9)	35.9 (6.7)
OJD (%)	-3.1 (18.6)	-12.0 (16.7)

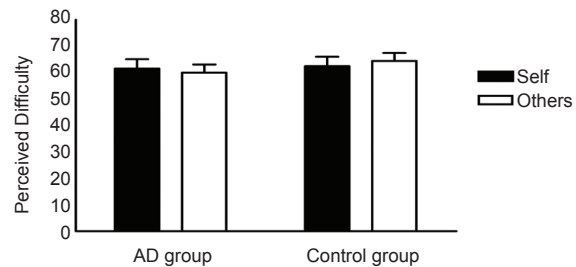
of condition indicated more negative evaluation for performance after failure (Table 3).

*Perspective taking*

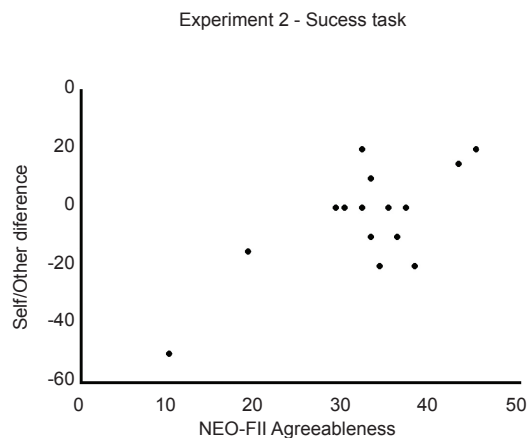
The ANOVA showed no significant condition x group x perspective interaction ( $F(1, 40) = 0.07, p = .788$ ), condition x group interaction ( $F(1, 40) = 0.28, p = .602$ ), perspective x group interaction ( $F(1, 40) = 0.97, p = .331$ ; Figure 3), group ( $F(1, 40) = 0.39, p = .534$ ) or perspective main effect ( $F(1, 40) = 0.01, p = .915$ ), but a significant condition x perspective interaction ( $F(1, 40) = 12.78, p = .001$ ) and main effect of condition ( $F(1, 40) = 27.17, p < .001$ ). The condition x perspective interaction indicated lower attribution of difficulty for self vs. other for success ( $p = .040$ ), but no significant differences for failure ( $p = .082$ ). The main effect of condition showed higher attribution of difficulty for failure relative to success.

*Associations between perspective taking and pre-morbid personality*

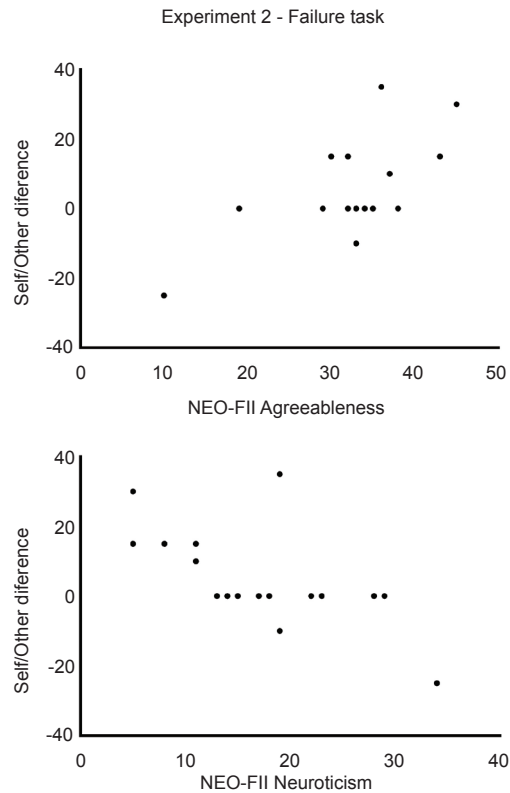
The perspective taking summary score was significantly correlated with agreeableness in the success task ( $r = .69, p = .015$ ; Figure 4) and agreeableness ( $r = .67, p = .020$ ) and neuroticism (failure task:  $r = -.65, p = .028$ ; Figure 5) in the failure task. There was also an association between perspective taking for the success memory task and neuroticism ( $r = -.56$ ), but



**Figure 3** – Perceived difficulty for self and others during Experiment 2



**Figure 4** – Association between pre-morbid personality and perspective taking during success in Experiment 2.



**Figure 5** – Association between pre-morbid personality and perspective taking during failure in Experiment 2.

after corrections for multiple testing this was no longer significant ( $p = .115$ ). No other associations were statistically significant.

## Discussion

In summary, the findings suggest that in early AD there are altered patterns of metacognition and perspective taking. In terms of awareness, there was worse discrimination between success and failure in the AD group in the context of matched levels of performance using the titration technique. For perspective taking, the AD group consistently suggested that others would do as well as they themselves did, despite their cognitive impairments, whereas the controls indicated others would perform worse than they themselves did in the reaction time tasks, but similarly in the memory tasks. Finally, in the AD group, attribution of difficulty for self/other correlated with pre-morbid personality traits such as neuroticism and agreeableness.

The findings on metacognition have already been discussed elsewhere (Mograbi *et al.*, 2012) and are presented here to provide context. In both experiments, AD patients show a pattern of underestimating performance during success and overestimating it during failure, exhibiting a swing in OJD estimations according to the condition. These results indicate that there is no positive bias in unawareness in AD, with patients being poor in evaluating their performance for

both success and failure. To the best of our knowledge, this is the first study to explore awareness of success performance in AD, which was made possible by the performance control exerted by the software. In contrast, controls show a steady pattern of slight underestimation of ability regardless of task type or condition. Regarding the control group performances as a baseline, the AD group showed a similar response overall, employing a heuristic of answering at the middle point of the scale because of poor discrimination between conditions (Moulin, 2002). Overall, these results are in agreement with various other findings which suggest metacognitive impairments in AD, with failure to evaluate their performance on tasks correctly (for reviews, see Pannu & Kasniak, 2005; Souchay, 2007).

In line with their lack of self-performance awareness, the AD group suggested that other people of the same age would find the tasks as difficult as they themselves did, in both experiments, regardless of task condition (failure or success). This reinforces findings of poor awareness about their state and cognitive deficits, since they rated themselves as able as others of the same age. In addition, it also suggests that people with AD have difficulties with perspective taking, being impaired in the ability to put themselves in someone else's position, which is in agreement with previous studies (Salmon *et al.*, 2005; Ruby *et al.*, 2009). Nevertheless, it has been suggested that people with AD may be accurate when evaluating their own or others' performance when exposed to evidence in a third-person perspective (Clare *et al.*, 2012). The difference in findings between these studies can possibly be explained by the fact that patients did not have access to recorded material or vignettes, having instead to answer to a question and imagine themselves as someone else, which arguably has a higher cognitive demand.

The deficits seen in perspective taking and awareness may in fact be linked with a central impairment such as executive dysfunction underlying both of them. In this respect, it has been suggested that difficulties in the ability to take a third-person perspective may play an important role in anosognosia in AD (Ruby *et al.*, 2009). It is possible that patients who lack preserved perspective taking abilities are less able to benefit from general semantic knowledge when evaluating their cognitive abilities and performance.

Regarding the perspective taking results, the control participants showed different patterns of response in each experiment. With the reaction time tasks, they suggested that other people of the same age would find the tasks harder, whereas for the memory tasks they judged other people to have the same difficulty as themselves. One potential explanation for this discrepancy is that controls are more sensitive to changes in cognitive (e.g., memory) than physical function (e.g., reaction time). It is possible that these findings are related to systematic biases present in older people when evaluating their memory abilities.

For example, there is considerable evidence suggesting an increase in reporting of memory problems with older age, with cases of over-reporting of difficulties (Dobbs & Rule, 1987; Bolla, Lindgren, Bonaccorsy & Bleecker, 1991). Future studies are needed to explore this further, for example, comparing younger and older adults. A further finding is that the difference in scores between difficulty for 'self' and 'others' correlated strongly in people with dementia with personality measures, with higher neuroticism and agreeableness being associated with attribution of harder difficulty for self/easier difficulty for others. These findings make sense if it is considered that the neuroticism factor concerns feelings of inferiority, and agreeableness includes characteristics such as being kind and sympathetic towards others (Costa & McRae, 1992). It also highlights how the concept of awareness may be influenced by factors operating at a higher attributional level (Mograbi, Ferri et al., 2012).

In summary, the current study suggests that although people with AD have difficulties evaluating their ability on cognitive tasks, they also fail to judge realistically how other people of the same age would perform on the same tasks. From a clinical point view, this highlights the pervasive effects of unawareness in AD, with potential influence on social interaction. The findings also suggest that the technique of introducing a third-person perspective appraisal as a means of improving awareness, may have a reduced effect in AD, but future studies are needed to explore this issue further.

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### Conflict of interest

The authors declare no conflict of interest.

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