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## Self- and other-evaluation in Alzheimer's Disease

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## Abstract

**Background:** Impaired awareness of ability is common in dementia and has important clinical implications. Evidence from different clinical groups has shown that awareness can vary according to whether evaluation refers to self or other performance. **Objective:** The present study aimed to investigate awareness for self- and other-performance in Alzheimer's disease (AD) patients, exploring if results vary according to cognitive domain of the tasks. It was hypothesized that, particularly for memory tasks, AD patients would be inaccurate in relation to self- but not other-performance. **Method:** Twenty-two mild to moderate AD patients and twenty-two healthy older adults participated. Two tasks, with reaction time (RT) and working memory tasks, were carried out, and each had a success and a failure condition. Participants were asked to estimate their own performance, as well as the performance of another person they observed. Awareness of performance was measured comparing participant estimations of performance with actual performance. **Results:** For both the RT and working memory tasks, results indicate that participants from both groups overestimated the performance in the failure condition and underestimated the performance in the success condition. They tended to overestimate more the performance of the other person compared to themselves. Additionally, for the working memory task, AD patients tended to overestimate more performances compared to controls. **Conclusions:** Findings suggest that the AD and control groups present the same pattern, with attribution of better performance to another person. For the AD group, the pattern of response was different for memory tasks, which may suggest domain-specific limited awareness.

**Keywords:** Alzheimer's disease, Dementia, Awareness, Metacognition, Perspective-taking

## 1. Introduction

Lack of awareness about the condition, cognitive deficits and personal ability, referred to as anosognosia, is a common characteristic of dementia [1, 2], with an important impact on patients and their caregivers [3]. Studies have shown that unaware people with Alzheimer's disease (PwAD) have diminished treatment adherence [4], engage more often in unsafe behaviors [5] and present impaired decision making capacities [6]. Additionally, unawareness has been related to increased caregiver burden and impaired caregiver's quality of life [7, 8].

Anosognosia represents a complex and multifaceted phenomenon [9, 10], associated with impairment in different cognitive mechanisms (e.g., [11]) and neuroanatomical networks [10, 12], also being impacted by psychosocial factors, such as culture [1] and premorbid personality [13]. Anosognosia in dementia has also been known to vary depending on illness severity [1], but this relationship is nonlinear [14]. The heterogeneity of anosognosia, particularly in AD [7], has been incorporated into theoretical models of the phenomenon [15], which try to explain, for instance, how patients may exhibit unawareness of deficits in one domain, but not in another, or how similar clinical presentations may have distinct etiologies.

Awareness of personal ability may be linked to metacognition, which is defined as the knowledge and reflective capacity one has concerning one's own cognitive functioning [16]. Metacognition, which includes monitoring and control processes [17], may be explored with paradigms investigating item-by-item or global judgments, before or after performance in cognitive tasks [18]. Although the concept of anosognosia is broader than that of metacognition, at heart of both concepts is the difference between objective performance and subjective

evaluations [18]. Additionally, it has been shown that there is overlap between anosognosia and metacognition. Indeed, when asked to predict their own performances, patients who are clinically rated as having anosognosia tend to overestimate their abilities [19, 20], inaccurately predicting their memory performance at multiple time points [21, 22]; for a review, [18]. Some evidence indicates that specific metacognitive paradigms may be particularly linked to anosognosia (e.g. feeling of knowing, FOK; [23]). Difficulties of people with AD to evaluate their performance may be linked to specific cognitive abilities, such as recollection [18]; several studies in AD have shown an association between memory deficits and metacognition of memory ability [24, 25], with those patients with more preserved memory displaying a greater monitoring of own's memory ability [26]. Metacognition of memory ability in AD may also be linked to performance in inter-domain nonverbal tasks comprising executive and memory domains (e.g. nonverbal fluency and nonverbal memory tasks) [26]. However, as pointed by [18], findings regarding metacognition in PwAD may vary depending on the type of metacognitive tasks (feeling of knowing vs. judgment of learning) and metrics (e.g. relative vs. absolute accuracy of metamemory judgments). It is worth noting that metacognition of memory ability has been linked to right hemisphere function (e.g., [27]), which has also been implicated in anosognosia, not only in AD (e.g., [28]), but also in other conditions [29].

It has been shown in different clinical groups that awareness about one's ability can vary according to the perspective through which the information is presented. For example, in the context of anosognosia for hemiplegia, studies highlighted improved awareness of symptoms when patients were allowed to see themselves in a video [30, 31]. Similar results have been observed in the context of psychosis [32-34]. Additionally, findings suggest that unaware patients may be able to acknowledge deficits in others [35], something which has been observed

in the case of anosognosia for hemiplegia [36-38], and psychosis [39]. By contrast, in left-brain-damaged patients suffering from anosognosia for apraxia, video manipulation does not lead to improvement in evaluation of self-performance [40, 41], but recognition of errors in others may still be preserved [40]. Despite the different etiology of the conditions, studies indicate that self- and other-awareness may be independent processes (e.g. [35, 42, 43]), as well as being dependent on the perspective through which the information is presented. This notion is included in theoretical models of awareness, such as the Cognitive Awareness Model [15], which suggests different memory records for evaluation of self and other, with personal semantics supporting self-evaluation, and general semantic knowledge anchoring other-evaluation. Nevertheless, a limited number of studies has explored this issue in dementia.

Looking specifically at these studies, it is unclear whether or not people with dementia are more accurate when evaluating another's performance as compared to their own, and whether this differs as a function of who the other is (e.g., caregiver or fictional person) (for a review, [43]). In a study by Mograbi and colleagues, PwAD were asked to judge how difficult a task was for them and would be for someone else their own age [44]. The results showed that PwAD predicted that others would find the task as difficult as they themselves did, despite their cognitive deficits, suggesting reduced awareness of ability. In a second study, Duke et al. [45] asked PwAD to estimate their own performance, as well as their spouse's performance and that of a fictional patient with moderate cognitive impairment in comparison to normative data. The results showed that PwAD overestimated themselves, as well as the fictional patient, but made accurate estimations of their spouse's performance. However, using a vignette technique, Clare et al. (2012) [34] explored the ability of people with dementia to appreciate the deficits of a fictional person, who was presented either as a typical case of advanced or early-stage dementia

or of healthy aging. The results showed that the participants, even some who had reduced levels of awareness, were able to correctly identify and offer appropriate advice for the problem that was described in the vignette. Heterogeneity in findings in this field may also be linked to a diversity of perspective-taking processes, for instance with evidence for dissociable neural systems for cognitive and affective perspective taking [46].

As such, while there is some evidence that PwAD may more accurately estimate another's performance in comparison to their own, there is no consistent pattern of results that arises across existing studies. One important limitation of existing studies is that they have not addressed the inherent difference in ability between patients and spouses, which may introduce bias in the results. By using a computerized program which establishes a specific level of performance that is the same for all participants, the current study equated task difficulty levels across participants and between groups, allowing a less confounded examination of awareness for self- and other-performance in PwAD. For this purpose, PwAD and healthy older adults were asked to estimate their own performances and the performances of their caregiver/friend on two different types of cognitive tasks (reaction time [RT] and memory), after watching the individual complete the task in either a success or failure condition. Consistent with the previous literature indicating impairments in the evaluation of self-ability in PwAD (e.g. [1]), and given theoretical predictions that evaluation of others may rely on preserved general semantic information, we hypothesized that PwAD would be inaccurate in relation to the evaluation of their performance, but more precise in the case of their caregivers, with healthy older adults showing stable estimations regardless of the person evaluated (self/other).

This is in line with the idea of awareness as a multidimensional concept, varying according to its domain, also termed 'object of awareness' [7, 47]. Indeed, various studies showed domain-

specific anosognosia, with awareness for memory deficits being the most frequently impaired compared to awareness for other cognitive domains, such as attention, and for psychiatric and behavioral symptoms [48, 49, 50]. Bertrand et al. [51] investigated awareness of different objects and found that awareness for overall condition and executive functions is more impaired than awareness for disinhibition and apathy in PwAD. In this study, awareness of depression appeared not be associated with other forms of awareness, suggesting a partially independent construct. Considering the existing evidence, in the current study we employed tasks tapping into different domains (RT or memory), to investigate further this issue.

## 2. Methods

### 2.1 Participants

All participants were aged 60 years or older. Twenty-four participants with mild to moderate Alzheimer's disease (AD) were included in the study, recruited from the Centre for Alzheimer's disease and Related Disorders (CDA) of the Institute of Psychiatry of the Federal University of Rio de Janeiro (IPUB-UFRJ), Brazil. The clinical diagnosis of AD was made by a psychiatrist using clinical interviews with the patients and caregivers, cognitive screening tests, laboratory tests, and imaging. The participants were diagnosed with possible or probable AD according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV-TR, [52]) and National Institute of Neurological and Communicative Diseases and Stroke/Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA; McKhann et al., 2011, [53]) criteria. Patients with scores of 18 or above on the Mini-Mental State Examination (MMSE; [54]), in the mild to moderate range of dementia, were included in the study. To provide

comparison values, twenty-four age-matched control participants were recruited from a community centre and were screened for cognitive impairment using the MMSE, with education-adjusted norms [55].

Exclusion criteria in both groups were: 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); history of diagnosed psychiatric disorder or current comorbidity (for example, mood disorder or psychosis). Although no patient had a diagnosis of mood disorder, upon screening two PwAD and two control subjects showed depressive symptoms, with scores on the GDS-15 above the cut-off of 5 [56]. These four participants were excluded from the following analyses, which were conducted with 22 PwAD and 22 control subjects.

There were no significant differences between the groups in age, years of education and gender ratio (see Table 1). MMSE scores were significantly lower for PwAD.

PLEASE INSERT TABLE 1 HERE

## **2.2 Procedures**

Two success-failure manipulation (SFM) computerized paradigms, developed by Mograbi et al. (2012) [20], were used, one for the reaction time task (Task 1) and the other for the working memory task (Task 2; for a full description of the development of the tasks, see [57]). The SFM paradigms are designed to set and maintain a constant and similar task difficulty level, by first establishing the ability of the participant and then adjusting automatically the difficulty of the trials based on this ability level or individual threshold according to the condition (success or

failure). Participants were not informed that levels of difficulty would be manipulated. Level of performance was controlled by the computer program, such that regardless of the difficulty of the task, performance was kept at similar levels for all participants. To make the procedure look more natural, each task was composed of four phases: practice (four instructional trials at low difficulty levels), titration (to establish a success/failure threshold for each participant by increasing the difficulty level until the participant failed), initial success (9 out of 10 trials below the participants' threshold to acclimatize the participant to the task before the experimental manipulation), and experimental phase (the level of difficulty of most [9 out of 10] trials were below or above the individual's threshold depending on the condition). After the four trials of the practice phase, the trials composing the next phases continued without any indication of change to the participant. Tasks duration was matched in terms of time, having a total of 5 minutes each after the titration phase (30 seconds of initial success + 4:30 minutes of the experimental phase). After performing each task, participants were asked to watch their caregiver (mostly spouses), in the case of PwAD, or a friend of the same age, in the case of controls, performing the same task. Participants were in the same room and no interaction was allowed; in addition to instructions not to interact at the beginning of each task, any attempts to interact were curtailed – in practice, the latter seldom happened, and never during estimation of performance. Caregivers/friends were chosen due to convenience and availability during the testing session.

Two parallel versions were developed for each type of task in order to allow a success and a failure version exploring the same cognitive ability (see description below); tasks were made distinctive by non-essential features (see below). Figure 1 provides graphic examples of the tasks.

The order of tasks and conditions was quasi-counterbalanced among the participants, according to the following factors: Task 1 or Task 2 first; success or failure condition first in each task; and version allocated for success or failure, in each task.

### *2.2.1 Task 1 – Reaction time*

In version 1, a ‘car’ appeared on the left side of the screen moving to the right, with the participants having to ‘stop’ the car as soon as it appeared by pressing the spacebar of the keyboard. In version 2, objects (e.g. ball, egg or vase) appeared to fall from the ‘top’ of the screen and participants had to ‘catch’ the object by pressing the spacebar. In both versions’ participants received feedback after each trial (success: a traffic warden in version 1 and hand catching the object, both followed by a ‘clink’ noise; failure: in both cases a buzzer sound). 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). Results were established as a success if the participant was able to press the spacebar before the car/object disappeared and as a failure if they could not perform the task on time.

### *2.2.2 Task 2 – Working memory*

The two versions of the task were based around memory span tasks, thus measuring working memory. For version 1, a set of ten identical objects (e.g. teapot, bucket) were shown on a computer screen and these were highlighted individually in a random sequence using a red square surround. Immediately after, participants had to point to the same objects in the sequence

they were highlighted. For version 2, a sequence of digits ranging from 0 to 9 was presented both auditorily and visually to the participants, who immediately repeated it back sequentially to the experimenter. To reduce task demands on participants, in both versions the experimenter entered the response indicated by participants by clicking with the mouse or typing in a number pad. 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. Difficulty was manipulated by varying the length of the sequence from one to ten objects/digits.

PLEASE INSERT FIGURE 1 HERE

### **2.3 Measures**

#### *Awareness of performance*

An Objective-Judgement Discrepancy (OJD; [58]) method was used in which immediately after performing the task, participants were asked to rate how well they did, and ratings were then 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 by subtracting actual performance (expressed in terms of % correct) from estimation of performance, with positive scores indicating overestimation of performance. Similarly, after observing their caregiver/friend perform the task, participants were also asked to rate how well this person did, and using the same formula, an OJD score for other-evaluation was calculated.

## **2.4 Ethical issues**

All participants provided informed consent, with caregivers also giving their agreement for the PwAD to take part. The project was approved by the Federal University of Rio de Janeiro (UFRJ)/ Institute of Psychiatry Ethics Committee (Research Ethics Committee number 536.634) and the study was completed in accordance to guidelines of the Declaration of Helsinki.

## **2.5 Statistical analysis**

The analyses were performed separately for each task (Task 1 – Reaction time; Task 2 – Working memory). In order to confirm that the experimental manipulation of difficulty worked, a two-way mixed design ANOVA was conducted with performance in the tasks as the dependent variable, with condition (success/failure) as a within-subject factors and group (AD/control) as a between-subjects factor. Differences in awareness of symptoms were explored using the OJD measures as dependent variables in three-way mixed ANOVAs, with perspective (self /other) and condition (success / failure) as within-subject factors and group (AD/control) as the between-subject factor. Planned pairwise comparisons followed the ANOVAs.

## **3. Results**

### **3.1 Task 1 – Reaction time tasks**

Table 2 shows that the two groups were matched on their performance in both conditions as expected from the individual manipulation of task difficulty employed in the experimental

paradigm. The ANOVA showed no significant main effect of group ( $F(1, 42) = .01, p = .906, \eta_p^2 = .01$ ), or interaction between group and condition ( $F(1, 42) = 2.59, p = .115, \eta_p^2 = .06$ ). As expected, there was a main effect of condition ( $F(1, 42) = 662.64, p < .001, \eta_p^2 = .94$ ) with predicted worse performance in the failure condition.

For number of trials, the ANOVA showed a significant main effect of condition ( $F(1, 42) = 46.76, p < .001, \eta_p^2 = .53$ ), with more trials for failure (mean: 83.2, SE: 2.2) than for success (mean: 74.5, SE: 1.8), and group ( $F(1, 42) = 7.56, p = .009, \eta_p^2 = .15$ ), with PwAD doing fewer trials (mean: 73.5, SE: 2.7) than controls (mean: 84.2, SE: 2.7). There was no significant main effect of perspective ( $F(1, 42) = 2.31, p = .136, \eta_p^2 = .05$ ), interaction between condition and group ( $F(1, 42) = 2.58, p = .116, \eta_p^2 = .06$ ), perspective and group ( $F(1, 42) = 2.12, p = .153, \eta_p^2 = .05$ ), condition and perspective ( $F(1, 42) = 0.2, p = .660, \eta_p^2 < .01$ ), or condition x perspective x group ( $F(1, 42) = 0.03, p = .865, \eta_p^2 < .01$ ).

For the OJD (Table 2 and Figure 2), there was a significant main effect of condition ( $F(1, 42) = 131.42, p < .001, \eta_p^2 = .76$ ). These results suggest that overall participants tended to overestimate performance in the failure condition relative to the success condition. There was also a significant main effect of perspective ( $F(1, 42) = 5.71, p = .021, \eta_p^2 = .12$ ), indicating that overall the participants tended to overestimate more the performance of a known person compared to the estimation they made of their own performance. There were no significant interactions for perspective x group ( $F(1, 42) = 0.17, p = .687, \eta_p^2 < .01$ ), condition x group ( $F(1, 42) = 0.77, p = .385, \eta_p^2 = .02$ ), perspective x condition ( $F(1, 42) = 0.21, p = .646, \eta_p^2 < .01$ ), or perspective x condition x group ( $F(1, 42) = 3.46, p = .070, \eta_p^2 = .08$ ). There was also no main effect of group ( $F(1, 42) = 2.60, p = .114, \eta_p^2 = .06$ ).

PLEASE INSERT TABLE 2 HERE

PLEASE INSERT FIGURE 2 HERE

### 3.2 Task 2 – Working memory

Table 3 shows that the two groups were matched on their performance in both conditions as expected from the individual manipulation of task difficulty. The ANOVA showed no significant main effect of group ( $F(1, 42) = .63, p = .432, \eta_p^2 = .02$ ), or interaction between group and condition ( $F(1, 42) = 1.16, p = .287, \eta_p^2 = .03$ ). As expected, there was a main effect of condition ( $F(1, 42) = 547.58, p < .001, \eta_p^2 = .93$ ) with predicted worse performance in the failure condition.

For number of trials, the ANOVA showed a significant main effect of condition ( $F(1, 42) = 114.55, p < .001, \eta_p^2 = .73$ ), with more trials for success (mean = 26.3, SE: 0.7) than for failure (mean = 16.8, SE: 0.5), but no main effect of group ( $F(1, 42) = 2.79, p = .102, \eta_p^2 = .06$ ) or perspective ( $F(1, 42) = 2.87, p = .098, \eta_p^2 = .06$ ). There was also no significant interaction between condition and group ( $F(1, 42) = 0.11, p = .740, \eta_p^2 < .01$ ), perspective and group ( $F(1, 42) = 2.68, p = .109, \eta_p^2 = .06$ ), condition and perspective ( $F(1, 42) = 0.84, p = .365, \eta_p^2 = .02$ ) or condition x perspective x group ( $F(1, 42) = 1.68, p = .202, \eta_p^2 < .04$ ).

For the OJD (Table 3 and Figure 3), there was a main effect of condition ( $F(1, 42) = 41.14, p < .001, \eta_p^2 = .49$ ), a main effect of perspective ( $F(1, 42) = 9.66, p = .003, \eta_p^2 = .19$ ) and a main effect of group ( $F(1, 42) = 6.17, p = .017, \eta_p^2 = .13$ ). No significant interaction effects were found for perspective x group ( $F(1, 42) = 5.16, p = .476, \eta_p^2 = .01$ ), condition x group ( $F(1, 42) = 2.01, p = .163, \eta_p^2 = .05$ ), perspective x condition ( $F(1, 42) < 0.01, p = .952, \eta_p^2 < .01$ ), or

perspective x condition x group ( $F(1, 42) = 0.23, p = .632, \eta_p^2 < .01$ ). These results suggest that overall the participants overestimated performance in the failure condition relative to the success condition. Also, they tended to overestimate more the performance of a known person compared to the estimation they made of their own performance. Additionally, these results indicate that overall PwAD tended to overestimate performance more than the control subjects.

PLEASE INSERT TABLE 3 HERE

PLEASE INSERT FIGURE 3 HERE

#### 4. Discussion

The present work is the first study to explore experimentally the relationship between self- and other-evaluation, with controlled levels of performance, in PwAD and age-matched controls. The main hypothesis suggesting that PwAD would be inaccurate in relation to the evaluation of their performance, but more precise in the case of their caregivers, with healthy older adults showing stable estimations regardless of the person evaluated was only partially confirmed. Indeed, the results show that overall, and in both types of task, the participants (AD and controls) tended to overestimate performance in the failure condition and to underestimate it in the success condition. Additionally, our findings indicate that overall both groups made a higher overestimation when evaluating a known-person compared to when they evaluated themselves. Finally, the results suggest that there is an overall difference between the AD group and the

control group in the working memory tasks, highlighting that PwAD overestimated more performances compared to healthy older adults for this cognitive ability.

One question addressed by the present work was whether PwAD and healthy controls were making evaluations of performance (self and other) in the same fashion. Our findings highlighted that, for the working memory tasks, PwAD overestimated performances more compared to the control group. In addition to the comparison with the control group, taking into account the zero of the scale in the OJD measure (i.e. precise evaluation of performance), it can be seen that PwAD overestimate more self- and other-performance during failure in working memory in comparison to controls, although there is no significant interaction. This is in line with studies showing that PwAD present metamemory difficulties, with a tendency to be overconfident and make overestimation of performances (for a review see [18]). Nevertheless, the fact that the pattern of attributing better performance than controls is also seen in success and for others, may suggest a general bias to attribute better working memory performance in tasks, which is further supported by no such results being found for the reaction time tasks. Additionally, these results also highlight that the type of task has an impact on metacognitive abilities, with a group main effect for working memory only. This reinforces the notion that anosognosia is a multidimensional concept [9], being impacted by the type of measurement used and the object of awareness [7, 47]. Indeed, various studies showed domain-specific anosognosia, with awareness for memory deficits being the most frequently impaired compared to awareness for other cognitive domains, such as attention, and for psychiatric and behavioral symptoms [48, 49, 50]. It is important to note that in the current study awareness was measured at the level of performance monitoring [7] and this may explain differences in results to experimental approaches measuring awareness at different levels (e.g [35]). Future studies could benefit from

exploring self/other-evaluation in relation to evaluative judgment and metacognitive reflection as well [7].

Another question addressed in this study was whether the participants appraise the performance of a known-person differently than their own performance when groups perform at the same level. The results demonstrated that, in both types of task, participants consistently suggest that the known-person performed better than themselves (and in a few cases, such as for success in reaction time tasks, both groups appear to be more accurate [closer to the zero of the scale] in relation to others). This could be partially explained by social desirability [59], with participants being more lenient to others than to themselves.

Although current findings are in agreement with previous studies suggesting that people with dementia are considering their own performance and another person's performance in a different fashion [34, 45], the fact that control participants showed similar results may be suggestive of general cognitive factors in operation. For instance, attentional demands arguably differ between performing or watching another performing the task. Recent neuroimaging evidence supports the idea of distinct processes for self- vs. other-evaluation, suggesting that self- and other-information processing have different neural bases. Studies showed that the frontopolar, somatosensory, and inferior parietal cortices are implicated in the process of self vs. other distinction [60, 61, 62]. Although Ruby & Decety [60, 61, 62] relies on the theory of mind (ToM) mechanisms to infer others' emotions, both studies involved perspective taking. The notion of a distinction between self vs. other processing has also been included in the reformulated version of the Cognitive Awareness Model (CAM) [2, 15, 57]. In fact, the authors proposed different memory records for self- and other-information. Self-evaluation would rely on personal semantics, which is acquired through personal, social, and cultural experiences, and

represented in the Personal Database and an Autobiographical Conceptual Memory System. These memory systems are distinct from a Generic Memory System, which stores other material that permits evaluations of others and is based on general semantic knowledge.

Finally, this study also looked at the possible impact of the condition in which the task was performed (success vs. failure). Results indicate that, for both tasks, AD and control groups tended to overestimate their own performance and the ones of a known-person in the failure condition and to underestimate ability in the success condition. One potential explanation for these findings is the midpoint anchoring effect. Indeed, previous studies showed that in young and old healthy populations, there is a bias leading to answer at the midpoint of the scale when participants present a lack of discrimination in a task of performance judgments [20, 63, 64]. In the current study, underestimation of success and overestimation of failure in both groups may be, partially, due to this bias. Previous evidence highlights that this effect may be particularly relevant in cases of reduced awareness, such as in PwAD [20].

The development of the success-failure manipulation allowed experimental control of performance, such that all participants, regardless of group, had a similar level of success or failure. This mitigates two main biases in the awareness literature: (1) the fact that patient groups tend to perform worse than controls, leading to differences in awareness that are driven by performance and not estimation; (2) the lack of studies investigating awareness of successful performance, with a focus on failure and impaired ability. During the programming of the paradigms, an option was made to control for duration of the tasks, as opposed to number of trials. This was done because controlling for number of trials could have led to tasks that were much longer for PwAD, which would introduce other biases, such as information being less available due to memory impairments or participants being exposed to failure for longer periods.

This led to number of trials being different between groups in the reaction time task, with PwAD doing fewer trials due to being slower to respond, and conditions, with more trials during working memory success (longer span sequence) and fewer for reaction time failure (faster moving object). Although this design feature needs to be taken into account, the fact that a relative measure (percentages) was used to estimate performance minimizes the potential impact this may have when interpreting results.

Other potential limitations of the current study must be considered. The fact that participants were asked to evaluate a well-known person (caregiver or friend) may impact the interpretation of results. Indeed, Duke et al. [45] suggested the possible influence of the common history with the individual for whom the estimates are being made. In other-evaluation condition, for PwAD, most caregivers were spouses, while for the controls, the other person was a friend. Although spouses may have better knowledge about an individual's ability, the focus of the current study was not on perceived ability, but on observed actual performance after a cognitive task that had controlled levels of difficulty, such that all participants performed at similar levels. Given this focus on actual performance and not on general perception of previous or current ability, it is unlikely that proximity to participants had a major impact in the results. Another possible limitation of the study was the lack of a more general measure of judgement to investigate the possibility of a midpoint anchoring effect. Data from younger and older adults [65], as well as from AD patients [64], suggest that midpoint responses may happen in response to increased quantity/complexity of material, so this may be a potential explanation for results from the current study. Future studies should incorporate general measures to explore further this possibility. Further investigations of the difference between self- vs other-evaluation in AD are needed with alternative methods, such as evaluation of known vs. unknown individual.

## 5. Conclusion

In summary, the present study underlines the multidimensional aspect of awareness, with results pointing to a difference between self- and other-evaluation and to the influence of the object in awareness. In terms of clinical implications, these findings should be taken into account when assessing unawareness in clinical settings. The present study indicates a different pattern for awareness when evaluating performance in a working memory task vs a reaction time task. This suggests that awareness affects differentially distinct cognitive domains, but findings need to be further explored for levels of awareness other than performance-monitoring. In any case, this highlights the importance of a more extensive evaluation of patients' capacity to appreciate the presence of deficits and symptoms across different domains. Additionally, different attribution of performance for self vs other, as observed in both groups, can be used as a tool to foster self-awareness in clinical conditions. Future studies exploring the role of different cognitive factors impacting self- vs. other-evaluation may provide important directions for rehabilitation work.

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## Tables

Table 1 – Sample characteristics.

Variable	AD group (n=22)	Control group (n=22)	p-value
	Mean (SD)	Mean (SD)	
Age	78.1 (5.6)	75.2 (6.3)	.118
Gender*	17 / 5	18 / 4	.709
Years of education	8.1 (4.2)	10.2 (5.3)	.143
MMSE	21.5 (3.1)	26.7 (2.1)	< .001

\* # female/ male

Table 2 – Performance and awareness of performance (OJD) during Task 1 (reaction time) for

success and failure conditions in both groups.

Variable	AD		Controls	
	Self	Other	Self	Other
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
<u>Success condition</u>				
Estimation (%)	69.1 (14.1)	82.4 (9.7)	78.2 (13.7)	81.5 (11.6)
Performance (%)	78.8 (10.6)	83.3 (5.2)	82.1 (6.0)	82.3 (6.1)
<b>OJD (%)</b>	<b>-9.8 (18.0)</b>	<b>-0.9 (9.8)</b>	<b>-3.9 (12.9)</b>	<b>-0.9 (12.4)</b>
<u>Failure condition</u>				
Estimation (%)	52.7 (17.0)	47.8 (12.7)	52.2 (24.3)	61.4 (19.8)
Performance (%)	35.7 (16.1)	31.3 (12.5)	33.1 (10.8)	33.6 (11.5)
<b>OJD (%)</b>	<b>17.1 (15.4)</b>	<b>16.5 (8.7)</b>	<b>19.0 (20.6)</b>	<b>27.7 (20.5)</b>

Table 3 – Performance and awareness of performance (OJD) during Task 2 (working memory) for success and failure conditions in both groups.

Variable	AD		Controls	
	Self	Other	Self	Other
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
<u>Success condition</u>				
Estimation (%)	70.0 (14.1)	82.8 (13.0)	65.1 (17.2)	69.3 (18.0)
Performance (%)	75.7 (8.7)	78.2 (7.4)	79.0 (6.9)	78.8 (6.8)
<b>OJD (%)</b>	<b>-5.7 (16.5)</b>	<b>4.6 (14.2)</b>	<b>-13.9 (17.7)</b>	<b>-9.5 (16.9)</b>
<u>Failure condition</u>				
Estimation (%)	42.5 (12.7)	54.1 (14.1)	38.1 (24.3)	45.6 (21.5)

Performance (%)	35.0 (9.1)	38.4 (5.0)	34.4 (8.1)	34.7 (8.5)
<b>OJD (%)</b>	<b>7.5 (13.8)</b>	<b>15.7 (13.8)</b>	<b>3.8 (23.4)</b>	<b>11.0 (21.4)</b>