Short title: Face recognition

# Empathy of individuals with Alzheimer's disease (AD) towards other AD patients

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Background: The objective of this study was twofold. We assessed whether individuals with Alzheimer's disease (AD) demonstrate higher empathy towards people with the same disorder. We also assessed whether empathy may enhance the recognition of these peoples' faces.

Method: Twenty-seven mild AD participants and 30 healthy older adults were invited to retain faces depicting either people diagnosed with AD or healthy people. Participants were also invited to rate their empathy towards all faces.

Results: Although AD participants reported higher empathy for "AD-labeled" than for "healthy" faces, recognition was similar for both categories of faces. Healthy older adults also reported higher empathy for "AD-labeled" than for "healthy" faces. However, they demonstrated higher recognition for "healthy" than for "AD-labeled" faces.

Conclusions: Although our paper shows no effect of empathy on face recognition in AD, it provides a clinically relevant finding: individuals with mild AD can demonstrate significant empathy towards people with the same medical condition.

Keywords*:* Alzheimer's disease; empathy; face recognition; memory; own-group bias.

Alzheimer's disease (AD) is a neurodegenerative disorder that is characterized by the presence of beta-amyloid plaques and neurofibrillary tangles (McKhann et al., 2011). Its main feature at the cognitive level is memory impairment (McKhann et al., 2011). Memory loss in AD can be observed for face recognition. Research has shown compromised face recognition in AD (Bortolon et al., 2015; Brogård-Antonsen & Arntzen, 2019; Greene & Hodges, 1996; Hodges et al., 1993; Moyse et al., 2015; Plaza et al., 2012; Sava et al., 2017; Viccaro et al., 2019; Werheid et al., 2011). This impairment has been attributed to several factors such as impairment of the processing of facial emotional expressions (Allender & Kaszniak, 1989; Hargrave et al., 2002; Lavenu & Pasquier, 2005; Spoletini et al., 2008), impairment of general cognition (Luzzi et al., 2007; Torres et al., 2015), impairment of high-level visual processes (Lavallee et al., 2016), gnosic problems (Mazzi et al., 2020), and degeneration of the neural structures involved in emotional processing (Lavenu & Pasquier, 2005).

Although one may expect a general compromise of face recognition, as well as a decreased empathy in AD (Fernandez-Duque et al., 2009; Martinez et al., 2018), we assessed whether impairment of face recognition may be alleviated by activating the empathy of AD patients towards faces. Empathy is an adaptive process that provides the foundation for successful social interactions. It involves cognitive and emotional processes that allow individuals to mentally represent the mental and affective states of other people (Spinella, 2005). Compared to affective processes of empathy, cognitive processes of empathy are typically hampered by AD (Demichelis et al., 2020; Fischer et al., 2019). However, affective processes of empathy can be also affected by AD. In a study by Fernandez-Duque et al. (2010), AD and control participants were invited to watch videotaped interviews of people discussing emotional events in their lives. Participants were then invited to describe the interviewee's feelings. While no significant differences were observed

between AD patients and controls regarding basic emotions of the interviewee, AD patients showed difficulties when the displayed emotions became more variable and ambiguous.

We investigated in this study whether informing AD patients that faces belong to people diagnosed with the same disease would activate empathy towards them and consequently improve the recognition of their faces. Our study was inspired by research demonstrating relationship between common humanity, and even mindfulness, and face recognition in general population (Giannou et al., 2022; Giannou et al., 2020). Also, in a study by Hot et al. (2013), individuals with AD were asked to perform a face recognition task in two conditions: when the faces appeared progressively from the eyes region to the periphery (eyes region condition) and when the faces appeared as a whole (global condition). Face recognition in AD patients significantly improved in the eyes region condition, probably because their attentional focus was oriented towards the eyes, a region that is highly salient and decisive in discriminating the affective states of other people (Adolphs, 2008). The findings of Hot et al. (2013) are relevant as they suggest that orienting the attentional focus of AD patients towards the affective states of others may improve face recognition.

As we suggest, AD patients may demonstrate higher recognition of faces of people with the same disease. In our opinion, individuals with AD may empathize with people suffering from the same medical and cognitive symptoms, thus categorizing them as belonging to their own group and consequently showing high recognition of these people's faces. Our assumption is supported by the well-known own-group bias, i.e., the tendency to better recognize faces of in-group members (Malpass & Kravitz, 1969). Although the own-group bias in face memory was originally found in the context of race (Meissner & Brigham, 2001; Wiese, 2012), research has demonstrated the existence of the same bias in a variety of in-group/out-group dimensions, such as age (Anastasi

& Rhodes, 2005; Anastasi & Rhodes, 2006; Rhodes & Anastasi, 2012), gender (Cross et al., 1971; Halpern, 2000; Kimura, 1999; Voyer et al., 1995), sexual orientation (Rule et al., 2007), religious beliefs (Rule et al., 2010), political affiliation (Ray et al., 2010), and even minimal groups such as university affiliation (Hehman et al., 2010). Considering this literature, the aim of our paper was to investigate whether the own-group bias would be observed when AD patients process faces belonging to their own group (AD).

The social categorization theory also supports our assumption (Hugenberg et al., 2010; Levin, 2000; Sporer, 2001). According to this theory, the mere fact of categorizing faces as belonging to an in-group enhances their recognition, as opposed to faces categorized as belonging to an out-group. Social categorization suggests that categorizing people as own-group vs. other-group members may alter the depth or type of processing, in such a way that in-group faces are processed as individuals and other-group faces are processed as general representatives of a social category.

We investigated whether individuals with AD demonstrate higher empathy towards people with the same disorder. To this end, we asked AD patients to retain faces of age-and-gender-matched people who were described as diagnosed with AD and faces of people who were described as healthy. We expected higher recognition of "AD-labeled" than of "healthy" faces in AD participants. We further assessed the potential involvement of empathy, as faces of people suffering the same medical and cognitive condition may be more affectively laden for AD patients than faces of people without this condition. We therefore asked participants to rate how much they empathized with the "AD-labeled" and "healthy" faces. We expected higher empathy towards "AD-labeled" faces than towards "healthy" ones in AD patients.

# Method

## Participants

The study included 27 participants with mild AD (19 women and 8 men; *M* age = 71.70 years, *SD* = 4.76; *M* years of formal education = 8.78, *SD* = 2.26) and 30 older control adults (20 women and 10 men; *M* age = 69.30 years, *SD* = 6.13; *M* years of formal education = 9.13, *SD* = 2.43). All AD participants had a clinical diagnosis of probable mild AD and were recruited from local retirement homes. They were diagnosed with probable AD of the amnestic form by an experienced neurologist or geriatrician following criteria of the National Institute on Aging-Alzheimer's Association (McKhann et al., 2011). Healthy older adults were independent and living at their homes. They demonstrated normal cognitive functioning as evaluated in a neuropsychological battery (see below). They were matched with AD participants in both age [$t(55) = 1.60$, $p > .10$], sex [$X^2$ (1, $N = 57$) = .90, $p > .10$] and educational level [$t(55) = .57$, $p > .10$].

Exclusion criteria for all participants were: significant psychiatric or neurological disorder and history of alcohol or illicit drug abuse. All participants freely consented to participate and were able to withdraw whenever they wished. They all presented no major visual or auditory acuity deficits that would have prevented the completion of the study tasks. The study was approved by the ethical committee of the University of Nantes (2020-431).

## Materials and procedure

### *Neuropsychological assessment*

Cognitive performance of all participants was evaluated with tests of general cognitive functioning, working memory, inhibition and depression (scores are summarized in Table 1).

General cognitive functioning was evaluated with the Mini Mental State Exam (MMSE) and the maximum score was 30 points (Folstein et al., 1975); in accordance with the diagnosis, scores indicated that the patients were in the mild stage of AD. In the evaluation of working memory (i.e., spans), participants were invited to repeat a string of single digits in the same order (i.e., forward span) or in the reverse order (i.e., backward span). Inhibition was evaluated with the Stroop task (Stroop, 1935), consisting of three subtests: word-reading, color-naming and color-word interference. In the word-reading subtest, participants were asked to read 100 words printed in black ink, all words naming colors. In the color-naming subtest, they were invited to name the color of 100 colored ink squares. In the color-word interference subtest, they were asked to name the color of 100 color-words printed in incongruously-colored ink (i.e., the word "red" was written in yellow). The inhibition score referred to the completion time for the interference condition minus the average completion time for word-reading and color-naming. Depression was assessed with the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983). This self-report scale consists of seven items on a four-point scale from 0 (not present) to 3 (considerable). As recommended by Herrmann (1997), the cut-off for definite depression was set at > 10/21 points.

INSERT TABLE 1 HERE

***Face recognition***

Stimuli were 80 black and white pictures, each of which depicted a full face in frontal view. Pictures, depicting Caucasian faces, were extracted from the FACES Database (Ebner et al., 2010) and were controlled for luminance and size (620 × 480 pixels). The mean age of the individuals represented by the pictures ($M$ = 70.03 years, $SD$ = 4.67) was similar to that of the AD patients ($t(55) = .97$, $p > .10$) and healthy older adults ($t(55) = .54$, $p > .10$). To control for any potential effect of gender on face recognition (Caplan et al., 1997; Halpern, 2000; Kimura, 1999; Voyer et

al., 1995), forty photographs were women's faces and 40 were men's faces. To control for any potential effect of emotion on face recognition (El Haj et al., 2016; El Haj, Fasotti, et al., 2015; El Haj, Raffard, et al., 2015; Nomi et al., 2013), all pictures depicted neutral emotions, as controlled by the FACES database. The stimuli were presented on Microsoft PowerPoint 2013 coupled with a laptop computer and a 15-inch LCD display.

**Procedures**

The face recognition task included three phases: an encoding phase, a retention phase and a recognition phase. During the encoding phase, participants were instructed to look carefully at each face displayed. They were told that memory for faces would be tested in a subsequent recognition test. Forty faces were then presented in fixed random order, for 10 s each. From the FACES database stimuli depicting healthy adults, 20 faces (10 men and 10 women) were randomly assigned to the label "AD" and 20 faces (10 men and 10 women) were randomly assigned to the label "healthy. Participants were told that half the faces represented people diagnosed with AD and that the other half represented people with no neurological or psychiatric disorder. For all faces, participants were invited to rate their empathy towards each depicted person using a five-point Likert scale (zero = "not at all", one = "a little bit", two = "moderately", three = "quite a bit", and four = "extremely").

After the encoding phase, we collected sociodemographic data (e.g., age, education level, marital status) during the five-minute retention phase. During the recognition phase, participants were presented with 80 photographs in fixed random order for 10 s each. Half of the photographs were those previously used during the encoding phase and the other half were distractors. For each

photograph, participants were invited to decide whether it had been exposed in the encoding phase or not. The dependent variable was *d'* (i.e., proportion of hits minus the proportion of false alarms).

## Results

We first compared the recognition scores of AD participants and healthy older adults for faces depicted as "AD-labeled" or "healthy" and then compared the empathy of both groups with these faces. Owing to abnormal distribution of data observed with the Kolmogorov Smirnov test, we did not use parametric tests. Comparisons between groups were performed using Mann-Whitney's U tests and within-group comparisons were performed using Wilcoxon signed rank tests. For all tests, the level of significance was set at $p \leq 0.05$, and $p$ values between 0.051 and 0.10 were considered as trends. For mean comparisons, we also provided effect sizes by using Cohen's *d* criterion (Cohen, 1992) (0.20 = small, 0.50 = medium, 0.80 = large). Effect size for non-parametric tests was calculated following recommendations by Rosenthal and DiMatteo (2001), and Ellis (2010).

### *Recognition*

Recognition scores are depicted in Figure 1. Analyses showed lower general recognition (i.e., mean recognition for "AD-labeled" and "healthy" faces) in AD participants than in healthy older adults, with a respective mean of .30 (*Median* = .31, *Range* = .46, *SD* = .11) and .54 (*Median* = .55, *Range* = .78, *SD* = .17), ($Z = 5.07$, $p < .001$, Cohen's $d = 1.78$). Lower recognition was observed in AD (*M* = .30, *Median* = .25, *Range* = .63, *SD* = .17) participants than in healthy older adults (*M* = .46, *Median* = .46, *Range* = .88, *SD* = .23) for "AD-labeled" faces ($Z = 2.71$, $p < .01$, Cohen's $d = .77$). Lower recognition was observed in AD (*M* = .29, *SD* = .19, *Median* = .25, *Range* = .63,) participants than in healthy older adults (*M* = .62, *Median* = .66, *Range* = .75, *SD* = .20) for

"healthy" faces ($Z = 4.90$, $p < .001$, Cohen's $d = 1.71$). In AD participants, similar recognition was observed for both "AD-labeled" faces and "healthy" faces ($Z = .26$, $p > .1$, Cohen's $d = .10$). However, healthy older adults showed higher recognition for "healthy" faces than for "AD-labeled" faces ($Z = 2.82$, $p < .01$, Cohen's $d = .80$). Therefore, unlike our hypothesis, AD participants did not demonstrate an own-group bias whereas it was observed in healthy older adults.

INSERT FIGURE 1 HERE

***Empathy***

Empathy scores are depicted in Table 2. AD participants and healthy older adults reported similar general empathy (i.e., mean empathy for "AD-labeled" and "healthy" faces), with respective means of 2.25 ($SD = .91$) and 2.22 ($SD = .75$), ($Z = .43$, $p > .1$ Cohen's $d = .16$). For both, "AD-labeled" faces ($Z = .74$, $p > .1$ Cohen's $d = .28$) and 'healthy' faces ($Z = .35$, $p > .1$ Cohen's $d = .13$), AD patients and healthy older adults's rating of empathy was similar. Interestingly, AD participants showed higher empathy for "AD-labeled" faces than for "healthy" faces ($Z = 4.02$, $p < .001$, Cohen's $d = 1.25$), as was observed in healthy older adults ($Z = 3.98$, $p < .001$, Cohen's $d = 1.22$).

INSERT TABLE 2 HERE

***Further analysis***

We further assessed correlations between empathy and recognition. We found significant positive correlations between empathy for "AD-labeled" faces and recognition for these faces in AD participants ($r = .51$, $p = .004$) and healthy older adults ($r = .54$, $p = .003$). We found significant

positive correlations between empathy for "healthy" faces and recognition for these faces in AD participants ($r$ = .40, $p$ = .04) and healthy older adults ($r$ = .47, $p$ = .009).

## Discussion

We investigated recognition for "AD-labeled" and "healthy" faces in AD and healthy older adults, and whether recognition of "AD-labeled" faces may be associated with higher empathy towards these faces. Although AD participants reported higher empathy for "AD-labeled" than for "healthy" faces, recognition was similar for both categories of faces. Therefore, AD participants did not demonstrate an own-group bias for faces belonging to their group. Healthy older adults also reported higher empathy for "AD-labeled" than for "healthy" faces. However, they demonstrated higher recognition for "healthy" than for "AD-labeled" faces.

Similar recognition was observed for "AD-labeled" and "healthy" faces in AD participants. Although the memory advantage of the in-group (i.e., own-group bias) is one of the most replicated effects in the psychological literature, our AD participants did not show this bias for "AD-labeled" faces. The absence of own-group bias may be attributed to compromised face recognition in AD, preventing any effect of empathy on the recognition of "AD-labeled" faces. Interestingly, the literature has reported hampered face recognition ability in AD (Allender & Kaszniak, 1989; Bortolon et al., 2015; Greene & Hodges, 1996; Hargrave et al., 2002; Hodges et al., 1993; Lavallee et al., 2016; Lavenu & Pasquier, 2005; Luzzi et al., 2007; Moyse et al., 2015; Spoletini et al., 2008; Torres et al., 2015; Werheid et al., 2011). The reverse may also be true, if empathy is not salient enough to improve face recognition, as seen in our experimental design.

Our findings are are clinically and theoretically relevant as they provide evidence of high empathy in AD patients. Our findings are also important as they demonstrate relationship between

face recognition and empathy in AD, as demonstrated by our correlation analysis. Thus, at the clinical level, activating empathy may, somehow, activate recognition processing. Our findings are also noteworthy since the evidence regarding the effect of AD on socio-affective processing is not consensual. A longitudinal study suggested a significant decline in a range of socio-affective processes in AD, such as emotion recognition and detection of sarcasm (Kumfor et al., 2014). Other research suggested a compromised cognitive theory of mind (the ability to infer the mental states of other people) in AD, especially in higher-order cognitive theory of mind, i.e., "what X thinks I Paul thinks" (Baglio et al., 2012; Castelli et al., 2011; Chainay & Gaubert, 2020; Crova et al., 2013; Demichelis et al., 2020; Duclos et al., 2018; El Haj, Gely-Nargeot, et al., 2015; Laisney et al., 2013; Lucena et al., 2020; Ramanan et al., 2017; Zaitchik et al., 2006). However, affective theory of mind, i.e., the ability to infer others' emotions, seems to be relatively preserved in mild AD (El Haj, Gely-Nargeot, et al., 2015; Gregory et al., 2002; Keri, 2014). Therefore, despite their difficulty to infer others' cognitive states and intentions, mild AD patients seem to be able to infer other people's affective and emotional states. This is in line with previous research that assessed the ability to infer others' simple and complex feelings in AD (Fernandez-Duque et al., 2010). In this study, AD participants watched video-taped interviews of people discussing an emotional event in their life. They then answered questions about the interviewees' feelings. AD participants inferred simple emotions (e.g., happy, sad) as accurately as healthy older adults. However, when the displayed emotions were more ambiguous, performance of AD participants became impaired in comparison with that of healthy older adults. The neural basis of empathy in AD was investigated by Dermody et al. (2016), who observed compromised cognitive empathy in the disease. This compromise was found to be associated with the left-sided temporoparietal atrophy in the disease. Dermody et al. (2016) also found that deficits of cognitive empathy in AD were a

consequence of general cognitive compromise rather than a loss of empathy per se. Unlike processing the cognitive states of others, processing their affective states seems to be relatively preserved in mild AD. This is mirrored by our study that shows significant empathy towards "AD-labeled" people in AD patients.

This significant empathy towards "AD-labeled" faces was observed in both AD participants and healthy older adults. However, unlike AD participants, healthy older adults showed higher recognition for "healthy" than for "AD-labeled" faces, therefore demonstrating an own-group bias. This effect can be compared with the well-known own-age bias, i.e., superior memory for older faces than for younger faces in normal aging (Anastasi & Rhodes, 2006). Our findings can also be interpreted in light of the socioemotional selectivity theory (Carstensen et al., 1999; Carstensen et al., 2011), according to which older adults become more discriminating in social interactions since they disengage from negative contacts that provide less satisfying emotional experience. The socioemotional selectivity theory thus posits that older adults demonstrate a memory bias for positive information, as has been supported by a research on memory in aging (El Haj, Fasotti, et al., 2015; El Haj, Raffard, et al., 2015; Fernandes et al., 2008; Spaniol et al., 2008). Therefore, the higher recognition for "healthy" faces in healthy older adults may reflect the striving for positive emotional information in normal aging.

One limitation of our study is the lack of distinction between affective and cognitive empathy. Affective empathy refers to responding to others' emotions with the same emotion, while cognitive empathy refers to the ability to intellectually assume other people's perspective. Future research should consider this distinction by inviting AD participants not only to rate their affective reaction towards AD-labeled people but also to describe and infer their experience. It would be also of interest to further activate empathy by inviting the participants to state the emotion that

they believe the actor is feeling, ideally in a larger sample size and by testing positive emotional faces because neutral faces, as used in our study, may limit the ability of AD participants to process the faces. In a related vein, it would be of interest to test cognitive vs affective empathy in AD patients toward dynamic faces. Although implementing dynamic faces requires sophisticated technological equipment, in everyday life, faces are not perceived in a static, isolated, context, but rather within a situational context providing enhanced affective information about the face.

In conclusion, the major finding was that AD participants demonstrated significant empathy towards faces depicting AD-labeled people. AD patients seem to be highly responsive to the subjective experience of people suffering from the same cognitive and medical conditions.

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**Conflict of Interest**

The authors declare no conflict of interest.

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Table 1

*Cognitive characteristics of Alzheimer's disease (AD) patients and* healthy older adults

| Task | | AD<br>***n* = 27** | Healthy older adults<br>***n* = 30** |
|---|---|---|---|
| **General Cognitive functioning** | Mini-Mental State Examination (MMSE) | 21.41 (1.40)*** | 27.80 (1.52) |
| **Working memory** | Forward span | 5.07 (.00)*** | 6.67 (1.47) |
| | Backward span | 3.70 (1.17)* | 4.67 (1.71) |
| **Inhibition** | Stroop | 59.04 (9.67)*** | 35.37 (9.32) |
| **Depression** | HADS | 8.07 (1.30)* | 6.80 (2.38) |

*Note*. Standard deviations are given between brackets; maximum score on MMSE was 30 points; performances on forward and backward spans referred to number of correctly repeated digits; scores on the Stroop referred to reaction time; cut-off on the HADS (Hospital Anxiety and Depression Scale) was > 10/21 points; differences between groups were significant at: $^{*}p < .05$, $^{***}p < .001$.

Table 2

*Empathy for "*Alzheimer-labeled*" faces and "healthy" faces in Alzheimer's disease participants and* healthy older adults

| | **Alzheimer participants** | **Healthy older adults** |
|---|---|---|
| **Alzheimer-labeled faces** | Mean = 3.04 (.98)<br>Median = 3.00, Range = 3.00 | 2.87 (.94)<br>Median = 3.00, Range = 3.00 |
| **Healthy faces** | Mean = 1.48 (1.25)<br>Median = 2.00, Range = 4.00 | Mean = 1.57 (1.01)<br>Median = 3.00, Range = 3.00 |

*Note*. Standard deviations are given between brackets; maximum score on empathy scale was four points.

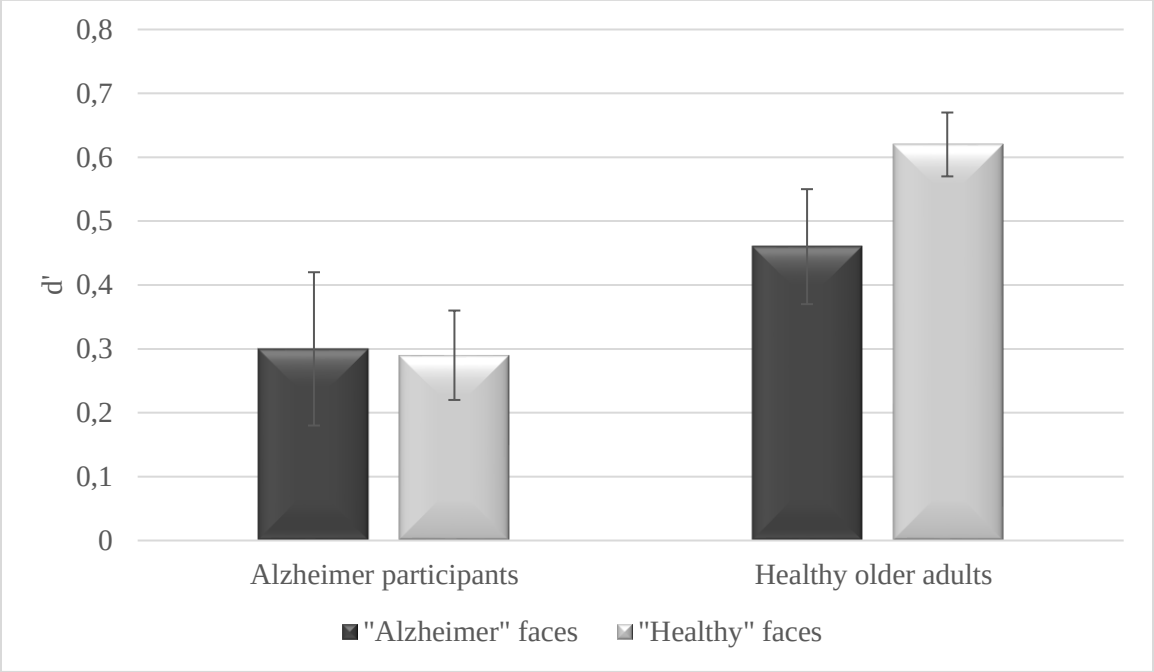


Figure 1

Recognition for “Alzheimer-labeled” faces and “healthy” faces in AD participants and healthy older adults. Error bars are 95% within-subject confidence intervals.