Prosocial capabilities in Alzheimer's patients

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Abstract

Objectives. To examine the decision-making of Alzheimer's patients in a simple, classic game focusing on their capabilities to implement social norms and common social preferences.

Methods. Patients with stage-I (very mild and mild) Alzheimer's disease were asked to participate in a Dictator Game, a type of game in which a subject has to decide how to allocate a certain amount of money between himself and another person.

Results. When we compared the results of treatments involving Alzheimer's disease patients (at an early stage) with those of identical treatments involving patients with mild cognitive impairment or healthy elderly controls, with similar ages and social backgrounds, we did not find statistically significant differences.

Discussion. This finding suggests that stage-I Alzheimer's disease patients are as capable of making decisions involving basic social norms and preferences as other individuals of their age. Whatever brain structures are affected by the disease, they do not appear to influence, at this early stage, the neural basis for cooperation-enhancing social interactions.

Keywords: Alzheimer patients, social behavior, dictator games

Introduction

Alzheimer's disease (AD) is a neurodegenerative disorder that afflicts a growing part of our aging population. Progression from healthy aging to Alzheimer's dementia occurs in a subtle and graded fashion over perhaps a decade or longer. Consequently, individuals in the prodromal stage may often be inadvertently included in samples of apparently normal elderly subjects (Heden & Gabrieli, 2004). However, behavioral measures of cognitive impairment can be used to evaluate progression from healthy aging to mild cognitive impairment (MCI) to Alzheimer's disease, such that individuals with MCI can be selectively excluded based on their performance. MCI refers to an early, but abnormal, state of cognitive impairment (Artero, Petersen, Touchon, & Ritchie, 2006; Petersen, 2004). Phenomenologically, it is a transitional stage between normal aging and dementia in which patients complain about poor memory task performance, but do not meet the diagnostic criteria for Alzheimer's disease (Bondi, Jak, Delano-Wood, Jacobson, Delis & Salmon, 2008; Nelson & O'Connor, 2008). In a sample of normal older adults, some 3–5% will develop MCI each year. There is increasing evidence that individuals with MCI have a greatly increased likelihood of progression to Alzheimer's disease, with an annual rate of progression of 10–15% (Heiden & Gabrieli, 2004). Nevertheless, MCI cannot be considered an early stage of AD.

Much progress has been made in characterizing the behavioral and neural changes, particularly in memory systems that are associated with advancing age. The diagnosis of AD is mainly based on standardized neuropsychological tests that explore the preservation of higher functions. In particular, attention is given to the evaluation of consciousness, language, visuospatial function, memory, orientation, cognitive function, and thought. When properly

applied, neuropsychological investigation provides a correct diagnosis in more than 80% of patients, as judged against necropsy findings. Neuroimaging is increasingly being used, and can provide correct diagnoses in as many as 92–94% (Norberg, 2001).

Since Alzheimer's disease is a process that starts with mild cognitive impairments that are difficult to diagnose, and progresses towards a broad generalized state in which it becomes hard to separate primary signs from secondary non-specific consequences, the early manifestations of AD provide a useful model for analyzing the selective weakening of higher functions. These early manifestations occur roughly during stage I (i.e., in the first 1–3 years) of the disease (Hughes, Berg, & Danzinger, 1982; Reisberg, Ferris, & DeLeon, 1982), when learning deficits predominate and before other symptoms start to impair the patient's independence. In fact, it seems that the earliest neuropsychological deficits in AD are in short-term memory and in declarative episodic long-term memory (Petersen, Smith, & Waring, 1999). These deficits form the background to the typical anterograde amnesia distinctive of early AD, which is characterized by clear limitations on the ability to learn new information while the capability of evoking old memories is retained.

Although early AD and MCI patients share similar memory deficits, they are classified separately because additional cognitive functions and functional performance are impaired in AD. It is possible, then, to distinguish three groups of subjects, AD, MCI and healthy elderly controls (HEC), who may be expected to behave differently to the extent that their decision-making relies on mental structures that may be influenced in unique ways by the two conditions.

The importance of capacity assessment in older adults cannot be denied (Moye & Marson, 2007). In the human society, cooperation-enhancing social sentiments, like altruism, fairness or reciprocity, are central to many aspects of decision-making. In the paper, we explore

experimentally whether AD patients in the first stage of their disease experience “social memory” loss, which is the loss of capabilities that help regulate social interactions, such as the ability to show fairness and altruism, and the capacity to value one’s social standing, i.e., one’s reputation. These findings could help link degeneration in specific brain structures in AD patients with structures that are engaged in cooperative social interactions, that is the neural correlates of such cooperation-enhancing social norms as a sense of fairness, altruism and reciprocity. In this way, our observations could add to our understanding of the neural basis of one distinguishing feature of the human species, namely cooperative collective action.

To test the degree of “social memory” loss, we invited stage-I AD, MCI and HEC individuals to participate in a Dictator Game, DG (see Camerer, 2003, for references for this type of game). In this social game, one player, called the dictator, receives a specified amount of money from the experimenter, and has to decide how much of this money goes to another player (typically an unknown person). The other player, called the receiver, can only accept the money. This game involves the simplest form of decision-making in two-person bargaining, since no strategic consideration of the receiver’s reaction to the offer should influence the dictator’s decision. It is simple to understand and play, which makes it well suited to test subjects with cognitive impairments. It is also well documented. Thus, this game can provide useful tools for evaluating “self-interest” or “other-regarding” behavior in AD patients. Self-interest is key to explaining individual decision-making in economics. From this perspective, the dictator in a Dictator Game should give nothing to the other person. However, other-regarding behavior, which may itself evolve from maximizing behavior, must be invoked to explain human cooperation and the evolution of social norms that enhance cooperation. Other-regarding behavior may take different forms in different models, be it fairness (Fehr & Schmidt, 1999),

altruism (Andreoni, 1989), indirect reciprocity (Panchanathan & Boyd, 2004), or reputation building (Fehr, 2004), to name a few. The DG, being devoid of any strategic element with respect to the other player, the receiver, who in fact plays no active role in the game, illustrates that the decision to give a non-zero amount is other-regarding or driven by cooperation-enhancing social norms and preferences (see Camerer, 2003, for references on social norms and preferences). Consequently, by comparing the amount given by stage-I AD patients with that given by MCI patients and healthy elderly controls, we can approach the degree to which patients with stage-I AD continue to apply these social norms and social preferences.

Methods

The subjects in our DG experiment were randomly selected from the patient pool of the Hospital San Vicente in Alicante, Spain, and recruited by telephone by the staff of the Alzheimer's Centre at the Hospital. They were asked to participate in a session in which they would perform "some mental exercises". They were also informed of the estimated duration of the exercises and told that no physical examination or medical procedure would be carried out. There was no indication of any reward.

As mentioned above, subjects were classified in one of three groups depending on whether they had been diagnosed with AD or MCI, or had no diagnosed cognitive impairment. The diagnoses had previously been made by a highly experienced team (neurologist-neuropsychologist) following the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) and Alzheimer's Disease and Related Disorders Association (ADRDA; McKhann, Drachmn, Folstein, Katzman, Price & Stadlan, 1984) criteria. The candidates had to complete the Mini Mental State Examination (MMSE, Folstein) and the

Alzheimer's Disease Assessment Scale (ADAS, Mosh). Criteria for allocating the MCI pool followed Petersen et al. (1999) guidelines restricting the sample to amnestic MCI (aMCI) single domain type (Artero et al., 2006). Inclusion in the MCI group required MMSE score equal or greater than 24 and ADAS score equal or smaller than 10, and not meeting DSM-IV-TR (Diagnostic and Statistical Manual of Mental Disorders, fourth edition) dementia criteria. Inclusion in the AD group was based on the DSM-IV-TR and NINCDS-ADRDA criteria. The criteria established by NINCDS-ADRDA for labeling a patient as AD consist in finding at least one more impaired function (in addition to memory) among the so-called cognitive functions (aphasia, apraxia, agnosia, and executive functions). When only one of these functions is affected, the patient is classified as mild or Stage I.

Patients with other neurological, metabolic and psychiatric pathologies were excluded. All the patients recruited as AD and MCI received a complete neurological and neuropsychological evaluation at the time of the study.

In detail, the three groups of subjects were:

- *AD group:* hospital outpatients who had been diagnosed in the previous six months, and who were in the initial stage (stage I: very mild and mild stage) of the disease (Hughes et al., 1982; Reisberg et al., 1982);
- *MCI group:* outpatients who had also been diagnosed in the previous six months; and
- *HEC group:* invited subjects without mental impairments. The subjects in this group had a similar age and social background as members of the other two groups. This group comprised two types of subject: first, members of the patients' family and, second, volunteers from a State center for old people.

Subjects were overwhelmingly working class and had completed only a few years of schooling. Table 1 summarizes the sample. More details are provided in Appendix 2.

[Table 1 about here]

Groups of two to eight participants were taken to the experimental room, which was located in the hospital grounds. In each treatment, they were seated behind cardboard screens to protect their privacy, provided with an envelope, and given a present of ten €1 coins. In the double-blind version of the Dictator Game run in the US, in which participants are anonymous to other participants as well as to the experimenter, dollar bills are used (Eckel & Grossman, 1996; Hoffmann, McCabe & Smith, 1996)). Unfortunately, there are no paper €1 bills, which would have been much easier to conceal in an envelope. Bohnet and Frey (1995) also used coins in their experiments.

Instructions were read aloud. These described the receiver and asked participants to place any coins they wanted to allocate to the receiver inside the envelope, while keeping their share in their pocket or purse. At the end of each treatment, an experimenter collected the envelopes. Importantly, the word dictator was never mentioned.

Subjects were told that their names would not be revealed. However, in order to avoid a degree of complexity that might not have been easily handled by AD subjects, we decided against using a full-anonymity procedure, such as Hoffman et al. (1996) double-anonymous procedure, or any other complex procedure.

We implemented three sequential treatments:

- The anonymous treatment: the receiver was described as an anonymous person "like yourselves" who was located in another room in the building;
- The two-way identification treatment: to each dictator corresponded a receiver, who was of the same sex and of a similar age, who entered the room where the experiment was taking place and was personally introduced to the dictator as the person who would receive whatever money he/she allocated to the receiver. The intention of visual recognition was to turn the faceless receiver into full-fledged human being;
- The Red Cross treatment: the receiver was identified as the Red Cross (see Eckel & Grossman, 1996, for a description of a Dictator Game with a Red Cross receiver).

Each subject participated in all three treatments. The anonymous treatment took place first. Once it was over, instructions for the two-way identification treatment were read out, the receivers were asked to enter the room and were introduced to the dictators without names being mentioned. Thereafter, the receivers were escorted out of the room and the dictators made their decisions. Finally, instructions for the Red Cross treatment were read out and, after the envelopes for this last treatment were collected, the participants were dismissed. We did not test for order effects because our interest was in comparing differences among groups.

Results

As shown in the three graphs in Figure 1, our data indicate:

Observation 1: *the amounts given by the control, MCI and AD groups were indistinguishable in each of the three treatments* (see Figures 1a–1c).

No conventional statistical test (e.g., all three Kruskal Wallis tests for the between group comparison for each treatment show *p*-values above 0.23) could reject the null hypothesis that the three different groups behaved identically in each treatment.

Observation 2: *visual contact with the receiver in the two-way identification treatment did not change the pattern of giving observed in the anonymous treatment in any of the three groups.*

To our subjects, it appeared that a stranger was a stranger whether or not he or she was seen (e.g. Wilcoxon test, $p = 0.9$). This may indicate that, like healthy participants, stage-I AD patients can form abstract images of other individuals and can relate to them as they do with visually observed individuals.

Observation 3: *a significant increase in giving occurred in all three groups when the receiver was the Red Cross.*

The amount given to the Red Cross was found to be significantly greater (at $p < 0.0001$ level, using the Wilcoxon test for both pairwise comparison of anonymous and two-way identification, respectively, with Red Cross). In particular, when the results of the two-way identification treatment are compared with those of the Red Cross treatment, it can be seen that 48% of subjects in the AD group, 58% in the MCI, and 44% in the HEC increased the amount they gave. The more generous allocations to the Red Cross seem to indicate that all three groups were equally aware of the social context. In particular, the change in AD subjects' behavior that

occurred when moving from the first two treatments to the Red-Cross treatment was indistinguishable from the change that occurred in both MCI patients and HEC.

In summary, the decisions made by AD patients were indistinguishable from those made by MCI patients and healthy elderly participants.

[Figures 1a, 1b, and 1c about here]

Discussion

It is well known that DG results are quite sensitive to design details. In our study, see Tables 2 and 3, subjects gave on average more than in most previously reported DG experiments (e.g., Bohnet & Frey, 1999; Eckel & Grossman, 1996; Frey & Bohnet, 1995).

[Table 2 and Table 3 about here]

Subjects in most DG experiments are undergraduate students, with ages around 20, but in our experiment the average age is above 70. While it has been observed that "older adults" decision behavior is similar to that of young adults, Bellemare and Kroeger (2003), Berg, Dickhaut & McCabe (1995), Fehr, Fischbacher, von Rosenbladt, Schupp & Wagner,(2003), Kovalchik, Camerer, Grether, Plott & Allman, (2004) and Sutter and Kocher (2004) found that the degree of reciprocity, as indicated by the returns in trust games, becomes significantly higher as age increases. Age, therefore, could explain the more generous amounts of giving in our experiment compared to previous ones with students.

In addition, in most DG experiments subjects are recruited inside campuses with the promise of earning money when volunteering in an experiment. But, as Eckel and Grossman (2000) reported, subjects who are, instead, "corralled" for participation can behave very

differently. They compared the results obtained in DG experiments using student volunteers with those with pseudovolunteers. Pseudovolunteers were recruited in class to participate in an experiment during class time. In the latter group, 28.7% gave everything to charity and contributions were 22–50% higher than in the volunteers group, where only 5.2% gave everything. It appears that subjects in the pseudovolunteers group were motivated by "something other than the incentive structure built into the experimental design", which is another way of saying that self-interest did not drive their decisions. Since the participants in our experiment were more like pseudovolunteers than genuine volunteers, Eckel and Grossman's observations could explain some of the differences.

Finally, one should not disregard the effect of the participant's surprise that a procedure carried out in a hospital should result in money being earned. In fact, a number of subjects in all three groups stated that they had no entitlement to the experimental money, that they had not earned it, and, therefore, that they did not deserve to take it with them. They felt they could not possibly justify accepting money as "manna from the experimental heaven" to their husband or wife.

It should also be noted that, in our study, there was no difference between the results of the anonymous treatment and those of the two-way identification treatment. This contrasts with Frey and Bohnet's results (1995) which found that the amount given increased significantly from one treatment to the other (see Table 3, equal divisions increased from 25% to 71%). However, Frey and Bohnet used a between-group experimental design, whereas we used a within-group design, thereby promoting, perhaps, a higher correlation in giving behavior among treatments. But, most important, our subjects, as discussed above, *already* gave half or more in the anonymous treatment, which was very generous and could hardly be improved.

In any case, the important point is that, whatever factors drove the participants' generosity, they did not influence the three subject groups *differently*. Recall that since the three groups were recruited in an identical way for the same experiments in the same hospital environment, and had similar social backgrounds and ages, they only significantly differed in their cognitive abilities, according to the clinical tests. But the differential impairments in their cognitive skills had no effect on the amounts that they decided to share.

While descriptions comparing AD with normal elderly subjects indicate basic problem-solving disorders (see, e.g., Torralva, Dorrego, Sabe, Chemerinski & Starkstein, 2000; Lai & Karlawish, 2007; Martini & Domahs, 2003), it is well-known that AD patients are, nonetheless, capable of solving well-structured problems (Passini, Rainville, Marchand & Joanette,1995). Kim, Karlawish & Caine(2002) reviewed the relevant literature identifying thirty-two studies, which reached very heterogeneous conclusions. They concluded that research into the decision-making competence of cognitively impaired elderly persons is a growing field that is just beginning to yield findings with practical implications for preserving the autonomy and welfare of this group of vulnerable elderly patients.

It is well established that AD patients suffer from a semantic memory impairment (Daum, Riesch, Sartori & Birbaumer, 1996; Giffard, Desgranges, Nore-May, Lalevée, Beaunieux, de la Sayette, Pasquier & Eustache, 2002; Tippett, Gendall, Farah & Thompson-Schill, 2004), reduced executive control function (Voss & Bullock, 2004), as well as loss of task, and loss of detachment (Marson, Amis, McInturff, Bartolucci & Harrell,1999). Even in the early stages, AD patients have problems in updating the contents of their working memory and suppressing activation of no-longer-relevant information (Sebastian, Menor & Elosua,2006), and have

difficulties in handling decisions under risk or ambiguity (Delazer, Sinz, Zamarian & Benke,2007, Sinz, Zamarian, Benke, Wenning & Delazer, 2008).

But cognitive process amounts to much more than these functions, and other domains appear to remain conserved. While there is a differential impairment of recall memory, the personality, values, and substantial long-term memory remain preserved, as does implicit memory for recent events (Sabat, 2005). Similarly, AD conserve the capacity for acquiring and maintaining implicit affective dispositions even when explicit memory is impaired (Blessing, Keil, Linden, Heim & Ray,2006), and, at least in mild AD, one component of metamemorial ability (Waring, Chong, Wolk & Budson2008). These features probably underlie the observation of the retained ability to vote in patients with very mild to mild AD (Appelbaum, Bonnie & Karlawish, 2005; Irastorza, Corujo & Banuelos,2007).

That some cognitive components are preserved was described early (Nebes and Brady, 1990), and our results suggest that in early stages of the disease, the functioning of the neural circuitry responsible for the prosocial capabilities tested in the experiment appears to remain sufficiently well preserved and that the operational subset of this circuitry seems still capable of maintaining a large degree of normal social behavior. This is consistent with the observation that a broad range of complex cognitive abilities is preserved in patients with dementia of the Alzheimer type who cannot perform simple actions (see Beatty, Winn, Adams, Allen, Wilson, Prince, Olson, Dean & Littleford, 1994; Goldberg, 2005; Gregory, Lough, Stone, Erzinclioglu, Martin, Baron-Cohen & Hodges, 2002), and in agreement with our present understanding of AD, which generally accepts that lesions begin to appear in the temporal region, mainly in the hippocampus (Nordberg, 2001). In contrast, the structures involved in decision-making are mainly located in the prefrontal cortex, which is affected in more advanced stages of the disease

but which remains apparently unaffected early on. Changes in the performance of decision-making tasks would be expected in subjects with frontal pathologies (e.g., frontotemporal dementia or orbitofrontal lesions). In fact, some studies have shown that patients with orbitofrontal cortical lesions are unable to anticipate the negative consequences of their choices (Camille, Coricelli, Sallet, Pradat-Diehl, Duhamel & Sirigu, 2004; Reisberg et al., 1982). Stage-I AD patients do not usually show the loss of basic emotions and insight, the selfishness or the loss of interest that characterize other dementias, like frontotemporal dementia or cerebrovascular dementia (Bathgate, Snowden, Varma, Blackshaw & Neary2001; Boller, El Massioui, Devouche, Traykov, Pomati & Starkstein, 2002; Bucks & Radford, 2004). Clearly, a study of how patients with frontotemporal dementia perform in the DG would provide results that would complement our findings. However, our results appear to indicate that decision-making in the DG is performed without the involvement of short-term memory, clearly impaired in our AD patients.

Conclusions

This study did not demonstrate a statistically significant difference in the way stage-I AD patients, MCI patients and HEC perform in the DG, a game that involves the simplest form of decision making in two-person bargaining. Moreover, like the MCI patients and the healthy elderly participants, AD subjects gave more generously as the receiver changed from being an anonymous or visually-observed individual to a well-known charity.

This experiment enables us to conclude that the memory deficit characteristic of stage-I AD patients appears not to affect their performances when deciding how generous they should be to a third party. Paraphrasing Hoffman et al. (1996, p. 655), we can say that, if it is past experiences that drive participants' decisions, then stage-I AD patients have not lost their

memories of these experiences. If, on the other hand, it is the prospect of the future consequences of their decisions that shape them, then stage-I AD patients have not lost their concern for how their decisions will be judged. Like healthy subjects, AD patients bring their experiences and their reputation from the outside world into the experimental environment. This is consistent with healthy elderly patients.

To conclude, stage-I AD patients appear to be as capable of making decisions involving the prosocial norms and prosocial preferences that regulate altruism, fairness or reputation as any person of their age. Whatever brain structures are affected by the disease, it appears not to impinge seriouslyon the neural basis for cooperation-enhancing social sentiments at the early stages.

Although submitting AD patients to a decision-making task in social games is not easy, due to their cognitive impairments, our research suggests two fruitful lines of research. One, involving patients with more advanced AD in a DG game, in order to establish the degree of fading of social memories as the disease progresses. Secondly, relying on different social games, to further study the strategic behavior of Stage-I AD patients in social interactions: In particular, using public good games (Kagel & Roth, 1995) to check for selfish or cooperative behavior, and trust games (Camerer, 2003) to check for trust or trustworthiness. As these games can be designed to involve AD patients in *repeated* social interactions, they should allow for a more subtle understanding of how AD patients react when confronted with a variety of contributions from other players.

It is worth acknowledging the limitations that a poor understanding of the early dementia manifestations imposes on our study. Subtle deficits, that may elude detection, could be significant for the differential diagnoses with MCI (Nelson & O'Connor, 2008), although the

similar behavior of MCI and AD observed in our experiment suggests that better diagnostic tools will not affect our results. In fact, properly designed social games could be added to the new battery of tests proposed by Dubois, Feldman, Jacova, Dekosky, Barberger-Gateau, Cummings, Delacourte, Galasko, Gauthier, Jicha, Meguro, O'brien, Pasquier, Robert, Rossor, Salloway, Stern, Visser, Scheltens (2007) (incorporating the use of biomarkers through structural MRI, molecular neuroimaging with PET, and cerebrospinal fluid analyses) and, thereby, homing in on the social deficits associated with the neurological decline.

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For the instructions of the experiment and the patients raw data, please contact the authors.

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Tables

Table 1: Characteristics of the Three Subject Groups, Patients with Alzheimer (AD), Mild Cognitive Impairment (MCI), and Healthy Elderly Controls (HEC)

Subject group	Number	Males	Average age (standard deviation)
AD	23	14	75.7 (5.7)
MCI	15	6	73.6 (6.4)
HEC	25	15	70.6 (6.7)

Table 2. Average Amounts Given Out of 10 Euros (Standard Deviation in Parenthesis) by the Different Subject Groups (Patients with Alzheimer (AD), Mild Cognitive Impairment (MCI), Healthy Elderly Controls (HEC)) in the Three Treatments (Anonymous, Two-way and Red Cross.)

	Anonymous receiver	Two-way identification	Red Cross
AD	€6.52 (€6.17)	€6.69 (€7.04)	€8.04 (€5.5)
MCI	€6.59 (€5.92)	€6.42 (€5.37)	€8.52 (€5.26)
HEC	€6.44 (€8.02)	€6.48 (€5.81)	€8.24 (€7.58)

Table 3. Percentage of Subjects Giving Specified Proportions Reported in the Studies by Bohnet and Frey (1999), , Eckel and Grossman (1996) and Frey and Bohnet (1995) and in theThree Treatments (Anonymous, Two-way and Red Cross) in this Paper.

(Figures in this Study Pooled over All Three Subject Groups, Alzheimer (AD), Mild Cognitive Impairment (MCI), and Healthy Elderly Controls (HEC).)

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Amount offered	Anonymous receiver (Frey & Bohnet, 1995; Bohnet & Frey, 1999)	Two-way identification (Frey & Bohnet, 1995; Bohnet & Frey, 1999)	Red Cross (Eckel & Grossman, 1996) (Double-blind)	Anonymous receiver (this study)	Two-way identification (this study)	Red Cross (this study)
No offer	28%	0%	27%	1%	0%	0%
Equal division	25%	71%	17%	45%	48%	22%
More than half	0%	11%	15%	41%	40%	71%
Mean offer	26%	50%	31%	64%	64%	82%

Figures

Figure 1a. Relative frequencies of offers of a specific amount out of 10 Euros in the anonymous treatment, shown according to subject group: patients with Alzheimer (AD), mild cognitive impairment (MCI), healthy elderly controls (HEC).

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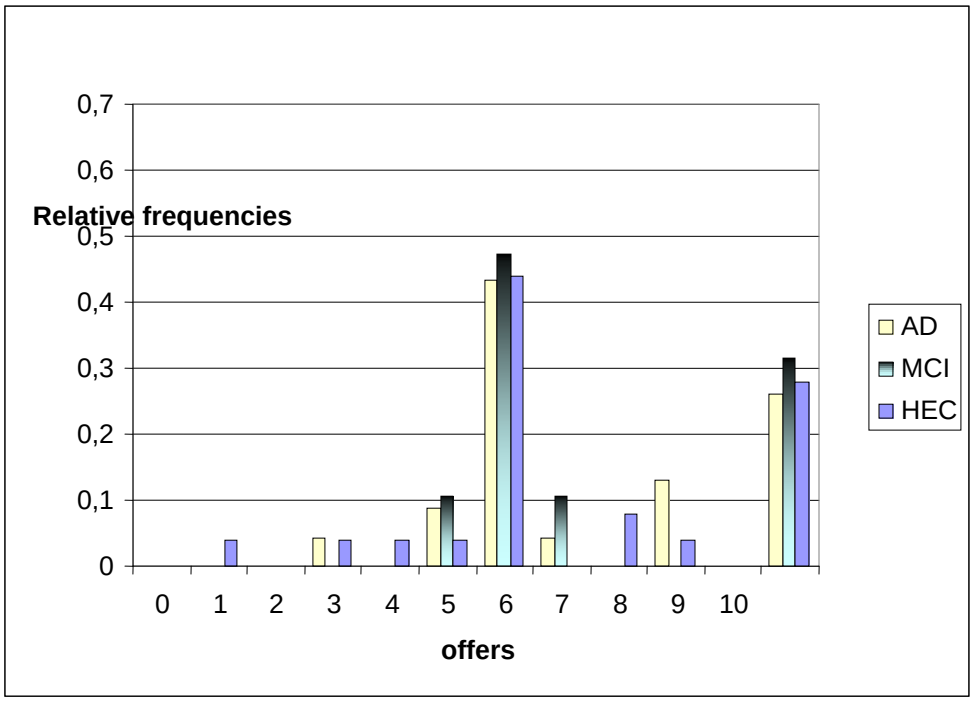

Figure 1b. Relative frequencies of offers of a specific amount out of 10 Euros in the two way identification treatment, shown according to subject group: patients with Alzheimer (AD), mild cognitive impairment (MCI), healthy elderly controls (HEC)

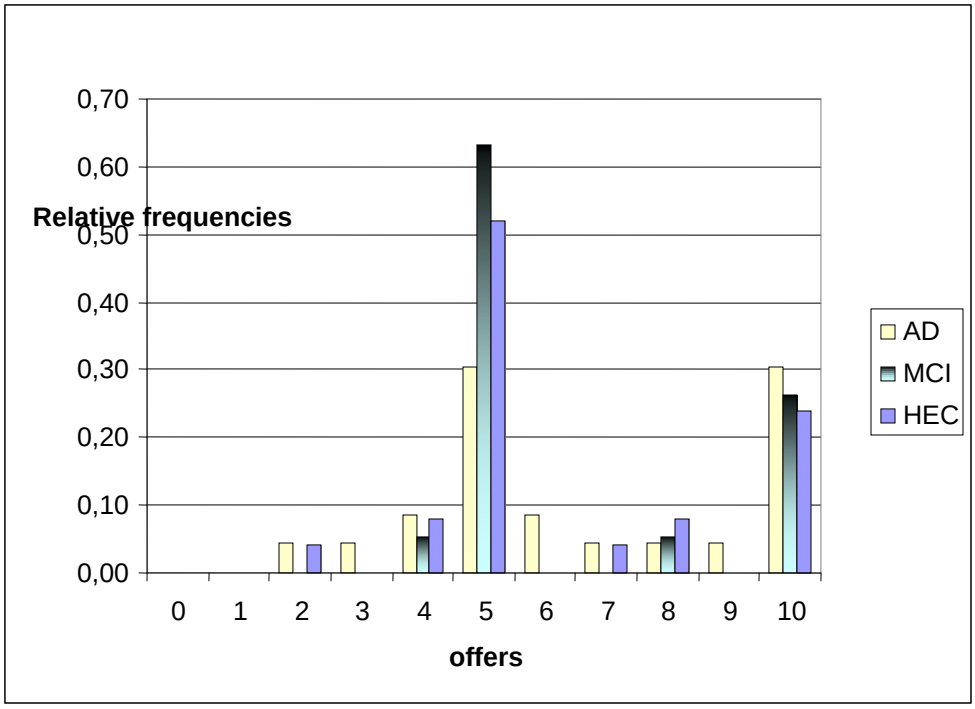

Figure 1c. Relative frequencies of offers of a specific amount out of 10 Euros in the Red Cross treatment, shown according to subject group: patients with Alzheimer (AD), mild cognitive impairment (MCI), healthy elderly controls (HEC)

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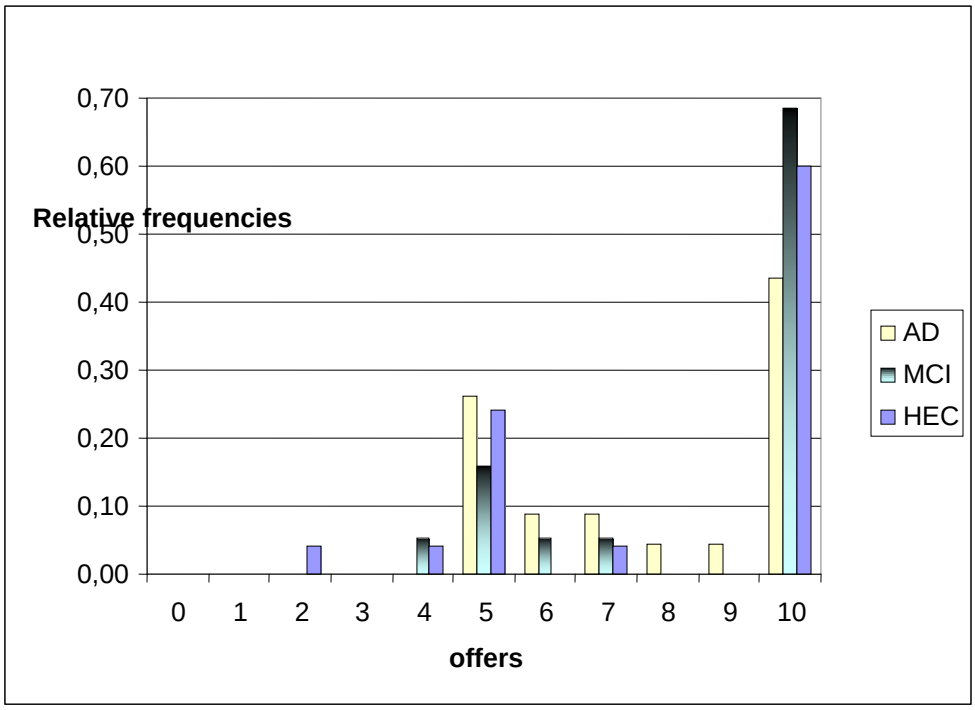

Appendix 1: Instructions

The following instructions were read aloud. The participants did not receive a written version as some were illiterate. These are the English translations of the original Spanish versions.

Instructions 1

Good morning. Thank you for participating in the exercise.

In this exercise, each person will be paired with another located in another room. You don't know this person and he or she doesn't know who you are either. In addition, you will not meet each other.

We will now give each of you 10 Euros and an envelope. You have to decide how much out of these 10 Euros you would like to give to the person you don't know and how much you want to keep for yourself.

Put the Euros you want to give to the other person (if any) inside the envelope. Keep the remaining Euros for yourself anywhere you want.

What you do is secret. Nobody will know your decision. For this reason, you are seated behind cardboard screens.

There is no hurry. You have five minutes to decide.

Are there any questions?

PAUSE

This part will be carried out separately after the previous experiment has finished. The persons who enter the room will be dressed conventionally, will be of the same sex as the patient, and will be not too dissimilar in age.

Instructions 2

In the following exercise, each of you will be paired with a person who will enter the room for a moment so that you can see him or her. (These persons enter and position themselves close to their paired subject's chair. The experimenter says "this is the person with whom you are matched" and invites the subjects to look at each other. After a few seconds, the experimenter says "thank you" and "you can go now", and the persons depart).

We will now give you ten Euros and an envelope. You have to decide how much out of these 10 Euros you would like to give to the person you just saw and how much you want to keep for yourself.

Put the Euros you want to give to the other person (if any) inside the envelope. Keep the remaining Euros for yourself anywhere you want.

What you do is secret. Nobody will know your decision. For this reason, you are seated behind cardboard screens.

There is no hurry. You have five minutes to decide.

Are there any questions?

PAUSE

Instructions 3

We will now give you an envelope and ten Euros to be shared with the Red Cross. You have to decide how much out of these 10 Euros you want to keep for yourself and how much you want to give to the Red Cross.

Put the Euros you want to give to the Red Cross (if any) inside the envelope. Keep the remaining Euros for yourself anywhere you want.

What you do is secret. Nobody will know your decision. For this reason, you are seated behind cardboard screens.

There is no hurry. You have five minutes to decide.

Are there any questions?

Appendix 2: Raw patient data.

	GROUP & TIME	CODE	DIAG-NOSIS	GENDER	AGE	SCHOOLING LEVEL	JOB TYPE	LABOR ACTIVITY	EXP 1	EXP 2	EXP 3
									Offers		
		CODE		GENDER F=female,			JOB TYPE*	Labor activity			
Sept. data	**MCI I**	A1	MCI	F	69	Basic reading and writing		Housewife	6	5	10
	9:00	A2	MCI	M	73	Elementary	E	Baker	10	8	10
		A4	MCI	M	78	Can read and write	E	Building worker	5	5	10
	MCI II	A5	MCI	M	66	High school	E	Quality control at nuclear power plants	5	5	10
	9:45	A6	MCII later diagnosed with AD	F	72	Basic reading and writing		Housewife	5	5	5
		A7	MCI	F	68	Can read and write	E	Cleaner	5	5	10
		A8	MCI	M	68	Elementary	E	Unskilled worker, shoe making	5	5	10
		A9	MCI	M	79	Can read and write	E	Farmer	10	10	10
Family A5	**CONTROL**	B1	Control	F	60	Elementary		Housewife	10	10	10
Family A6	**10:30**	B2	Control	M	79	Can read and write	E	Farmer	5	5	5
Family C1		B3	Control	F	77	Can read and write		Housewife	5	5	10
Family A7		B4	Control	M	69	Can read and write	E	Unskilled factory worker	5	5	10
Family A8		B5	Control	F	67	Can read and write		Housewife	5	10	10
Family C2		B6	Control	M	81	High school	E	Accountant	10	10	10
Family C3		B7	Control	F	69	High school	SE	Small shop owner	5	5	5
		B8	Control	M	79	Can read and write	SE	Fisherman	7	7	7
	AD I	C1	AD	M	80	Can read and write	E	Porter	10	10	10
	11:15	C2	AD	F	79	Elementary		Housewife	10	10	10
	AD II	C3	AD	M	71	Elementary	SE	Small shop owner	5	10	10
	12:00	C4	AD	F	79	Can read and write		Housewife	4	3	6
	AD IV	C7	AD	F	81	Illiterate		Housewife	5	6	5
	13:30	C8	AD	M	85	Elementary	SE	Porter	10	10	10
January data	**9:30**	1.1	MCI	F	73	Basic reading and writing	E	Cleaner	10	10	10
		1.2	MCI	M	72	Can read and write	E	Building worker	4	5	5
		1.3	AD	M	71	Elementary	E	Porter	8	9	10
Family 1.3	**10:00**	2.1	Control	F	69	Can read and write	E	Tailor	10	10	10
Family 1.2		2.2	Control	F	72	Illiterate	E	Farm worker	10	8	12
		2.3	Control	M	65	Elementary	E	Lorry driver	7	8	5

	10:30	3.1	Control	F	80	Can read and write	SE	Fishing entrepreneur (2)	3	4	4
Worker's Relative		3.2	Control	F	77	Can read and write	SE	Food shop owner	10	10	10
		3.3	Control	F	67	Elementary	E	Cleaner	4	4	5
		3.4	Control	M	64	Elementary	E	Garage manager	2	2	2
		3.5	Control	F	57	Elementary	SE	Office materials entrepreneur (11employees)	0	5	10
	11:00	4.1	MCI later AD	F	81	Can read and write	E	Cleaner	5	4	5
		4.2	MCI later AD	M	78	Elementary	E	Sound technician RNE	10	10	10
		4.3	MCI	M	70	Illiterate	E	Building worker	10	10	10
		4.4	MCI later AD	M	78	High school	E	Building worker	4	4	5
	11:30	5.2	AD	F	72	Elementary	E	Seller of ONCE coupons	5	5	10
		5.3	AD	F	59	Elementary	SE	Self-employed cleaner	10	10	10
		5.4	AD	F	73	Illiterate	E	Unskilled worker, tobacco factory			
		5.5	AD	F	74	Can read and write	E	Dressmaker	8	7	7
	12:00	6.1	MCI	M	89	Elementary	E	Docker	5	5	5
		6.2	MCI	F	70	Can read and write	SE	Self-employed dressmaker	6	5	7
		6.3	MCI	M	70	Can read and write	E	Miner	5	5	10
		6.4	MCI	F	79	Elementary	SE	Painter	10	10	10
Family 8.3	**12:30**	7.1	Control	M	70	Elementary	E	Hospital attendant	10	10	10
Family 8.2		7.2	Control	F	65	Elementary	E	Bus company worker	5	5	10
Family 8.1		7.3	Control	F	73	Elementary	E	Nurse assistant	5	5	5
Family 8.1		7.4	Control	M	73	High school	SE	Food comer-cialization entrepreneur (7 employees)	5	5	5
Family 8.4		7.5	Control	M	79	Elementary	E	Railway worker	8	5	10
		7.6; 5.4	AD	F	73	Illiterate	E	Unskilled worker, tobacco factory	5	5	5
	13:00	8.1	AD	F	80	High school	E	Nurse	5	5	10
		8.2	AD	M	71	Elementary	E	Accountant	10	10	10
		8.3	AD	F	69	Elementary	E	Nurse assistant	6	6	9
		8.4	AD	F	78	Can read and write	E	Tailor	5	5	6
	17:00	9.1	MCI	M	63	High school	SE	Electric material entrepreneur (25employees)	5	5	10

	9.2	MCI	M	83	Elementary	SE	Self-employed cobbler	5	5	6
	9.3	MCI	F	77	Can read and write	E	Kitchen assistant	10	10	10
	9.4	MCI	M	79	Can read and write	E	Farm worker	5	5	4
	9.5	MCI	M	73	Can read and write	E	Lorry driver	4	4	5
17:30	10.1	Control	F	67	Can read and write	SE	Self-employed embroiderer	5	5	10
	10.2	Control	F	60	Can read and write	SE	Catering – hotel business entrepreneur	5	5	10
	10.3	Control	F	75	Can read and write	E	Unskilled worker, aluminum factory	10	5	10
	10.5	Control	M	72	High school	SE	Decorator	5	5	10
18:00	11.1	AD	M	77	Elementary	E	Wooden floor installer	8	8	12
	11.2	AD	F	84	Elementary	SE	Catering – hotel business entrepreneur (6 employees)	5	5	7
	11.3	AD	M	76	Elementary	SE	Garage entrepreneur (3 employees)	2	2	8
	11.4	AD	F	74	Can read and write	SE	Self-employed cleaner	5	5	5

*Self-employed (SE), Employed (E). Three Subject Groups: patients with Alzheimer (AD), mild cognitive impairment (MCI), healthy elderly controls (HEC).