DIFFERENCES BETWEEN FRONTOTEMPORAL DEMENTIA AND PROBABLE AD PATIENTS REGARDING THE DISCRIMINATION OF FACIALLY CONVEYED EMOTIONS: A STUDY WITH SIGNAL DETECTION THEORY

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Abstract

Frontotemporal dementia (FTD) is a neurodegenerative disease characterized by behavioral disorders that suggest abnormalities of emotional processing. This study compares FTD patients, Alzheimer Disease (AD) patients, and a sample of matched controls regarding the discrimination of intensities of facially conveyed emotions. Two same-different roving tasks were used, with pairs of emotion-conveying faces (of a same person) and with pairs of neutral faces (same and different persons). Comparisons were based on sensitivity and criteria parameters derived from Signal Detection Theory. Patients performed worse than controls in the discrimination of emotional expressions, but not in the discrimination of different neutral faces. FTD patients performed worse than AD patients for intensities of Sadness and (less clearly) of Fear, but outperformed AD patients when intensities to discriminate were of Joy. This might suggest a differential pattern of sensitivity loss in the patients groups, dependent on the valence and activation level of the specific emotions.

Frontotemporal dementia (FTD) is a neurodegenerative disease characterized by behavioral disorders that suggest abnormalities of emotional processing. In the past few years several studies investigated the recognition of facial emotion by Frontotemporal dementia patients (Kessels et al., 2007, Fernandez-Duque et al., 2005, Keane et al., 2002, Lavenu et al., 1999, 2005, Rosen et al., 2002, 2004). Evidence gathered converges to suggest that inability to recognize facial emotions in FTD results from inability to recognize emotions rather than from failure in recognizing facial features. The aim of this study was to examine the discrimination of facial expression of emotions in patients with FTD and to compare it with that of patients with Alzheimer disease (AD). Although this study is part of a broader project, involving an inquiry on the relationships between SDT parameters of sensitivity and response criterion and a large spectrum of neuropsychological assessments currently performed over FTD and AD patients, only SDT parameters will be considered here, given the still reduced number of subjects for whom data have been collected. The present work has thus, for now, a provisional character.

Method

Participants

Six patients with Frontotemporal Dementia (FTD) (mean age: 75,1 years) and six patients diagnosed with probable Alzheimer Disease (AD) (mean age: 74,5 years), recruited at the Hospital Magalhães Lemos in Oporto, Portugal, took part in the study. All FTD patients were diagnosed according to the *Lund and Manchester groups* criteria for FTD (Neary D., Snowden J. S., Gustafson L., et al, 1998); all AD patients met the criteria set by the *Diagnostic and*

Statistical Manual of Mental Disorders (4 th edition) and *the National Institute of Neurological Communicative Disorders and Stroke Alzheimer's Disease and Related Disorders Association* for probable AD. Six healthy elderly subjects (mean age: 74 years) were used as controls, matched for gender, age, schooling and civil status. This group was enlisted at the same geographical area covered by the Hospital Magalhães Lemos, in Oporto. All participants, be them FTD patients, AD patients or controls, were free of severe medical conditions other than those pertinent to the study, and none was living at an institution. Normal levels of hearing and normal or corrected to normal visual acuity were also ensured. Informed consent was obtained from all subjects. Two separate experiments (emotion and non-emotion tasks) were done, each involving all FTD, AD and Control participants.

Stimuli

Stimuli consisted of faces selected from the *Japanese and Caucasian Facial Expressions of Emotion and Neutral Faces* (*(JACFEE & JACNeuF)* (Matsumoto & Ekman, 1988), which were subsequently assembled by pairs. Pairing was of two sorts: (1) Pairs of intensities of a same emotion (same person), with *Fear*, *Sadness*, and *Joy* as the selected emotions, in the emotion task; (2) Pairs of neutral faces (same or different persons) in the non-emotion task. Intensity degrees were produced by morphing at equal steps (with *Morpheus Software*) between neutral and maximum intensity expressions (according to the database normative ratings) of a person displaying a given emotion. Three levels of intensity (low, medium, high) were obtained this way for each of the emotions considered.

Assessment instruments

All participants, including matched controls, were given the Mini-Mental State Examination (Folstein *et al.*, 1975) and the Clock-Drawing Test (Strub, R. L. & Black, F. W., 1977) for cognitive screening, as well as the *Clinical Dementia Rating* (CDR) (Hughes et al., 1982), which classifies dementia along 3 stages of severity as a function of overall cognitive and functional impairment. Functional abilities were assessed with two Activities of Daily Living (ADL) Scales: the Barthel's Index (Barthel, 1965), addressing basic, "physical" ADLs such as grooming, eating, bathing, dressing, mobility, and the Lawton and Brody's Index (Lawton, 1969), targeting those of a more complex, "instrumental" character (e.g. managing money, using the telephone). The *Frontal Behavioral Inventory* (FBI) (Kertesz at al., 1997), which provides criteria for the differential diagnosis of FDT regarding probable AD and depression conditions, was administered to patients' caregivers. AD patients and FTD patients in our samples presented, as expected, highly significant differences in *FBI* scores.

Design and procedure

The experiment obeyed a same/different roving design embedded within a Signal Detection Theory (SDT) framework. Detection Theory is a general psychophysical approach that allows distinguishing between criteria/attitude and sensitivity parameters in performance (MacMillan & Creelman, 2005). Two separate experiments were done, one involving the intensity pairs (discrimination of emotion intensity) and the other the neutral faces pairs (discrimination of faces). The ordering of experimental blocks (one for each emotion) in the intensity experiment was handled through a latin-square. Overall balance between signal (different pairs) and noise (same pairs) was ensured in both experiments. Stimuli were presented at the center of a computer display located circa 40 cm ahead of the subject. Participants were simply asked to decide whether the two faces were "different" or "the same".

Results

I. Sensitivity Index

Task 1. Discrimination between emotion intensities

Figure 1 presents the results of FTD, AD and control subjects regarding sensitivity – indexed by d'_{sd} (Macmillan & Creelman, 2005) – obtained for different intensity levels of *Fear, Joy* and *Sadness.* Pairs of intensities always corresponded to the face of one same person.

Across all three groups, *Joy* provides the higher levels of d'_{sd} (better discrimination), while *Sadness* appears as the most challenging emotion for the two groups of patients (but not for the control group).

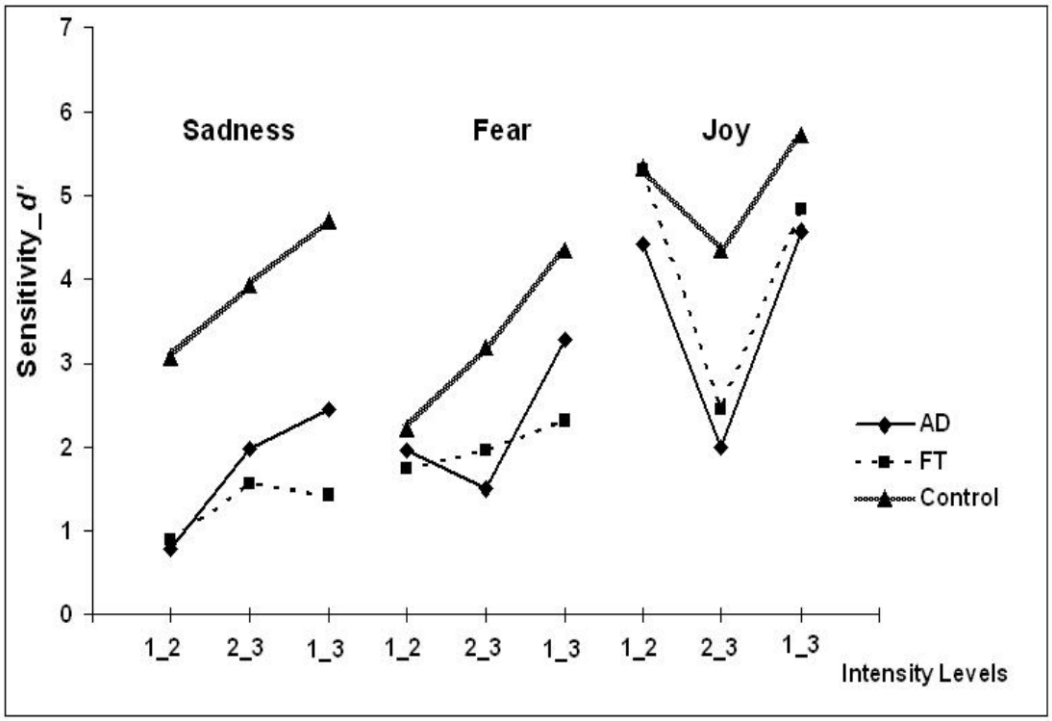

Figure 1. Patterns of d'_{sd} obtained for different emotions by the AD, FTD and Control groups (intensities in the abscissa: 1 – low; 2 – medium; 3 – high; number pairs identify the levels being compared)

The following graphs (see panels in Figure 2) offer a separate analysis of mean d'_{sd} within each emotion, together with the *p*-values of between-group comparisons (univariate ANOVAs followed by pairwise comparisons with Bonferroni correction).

Sadness has revealed a significant difference between the two groups of patients regarding controls (lower d'_{sd}), but no differences among AD and FTD patients. *Fear* has not provided clear differences, from a statistical standpoint, between any two groups. Nevertheless, a marginally significant difference ($p = .08$ - for a < 0.1 criterion alpha level) was apparent between the FTD and Control groups. *Joy* was associated with a significant difference between AD and Control subjects (lower d'_{sd} in the AD group).

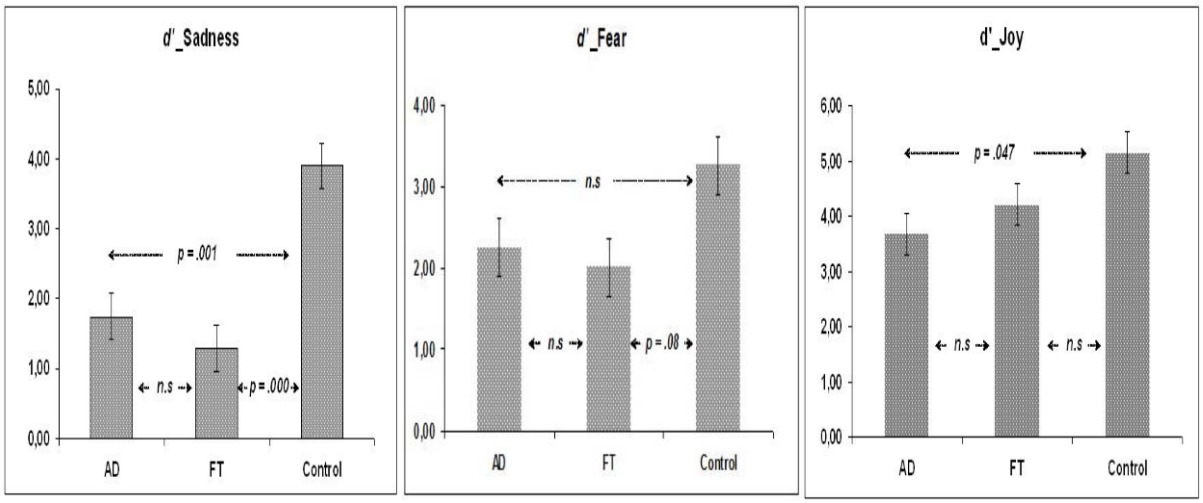

Figure 2. Mean d'_{sd} values across groups. Emotions: Sadness, Fear, Joy.

Sensitivity was thus larger for FTD as compared to AD patients when the emotion involved was *Joy*, but lower when discrimination concerned *Sadness*. Similar values of d'_{sd} were on the other hand found for *Fear* between the two groups of patients

Task 2. Discrimination between non-emotional faces

Figure 3 presents the results of FTD, AD and Control participants regarding the sensitivity parameter while discriminating among neutral faces of different persons.

Differences in d'_{sd} for the discrimination of non-emotional faces never reached significance either between the AD and FTD groups, or between any of these groups and the sample of controls. On the whole, outcomes suggest (conditional on the power of the statistical analysis achieved with this number of participants) an overall deficit of the groups of patients in the emotional tasks, while no similar deficit is apparent in the non-emotional task (similar d'_{sd} across all groups).

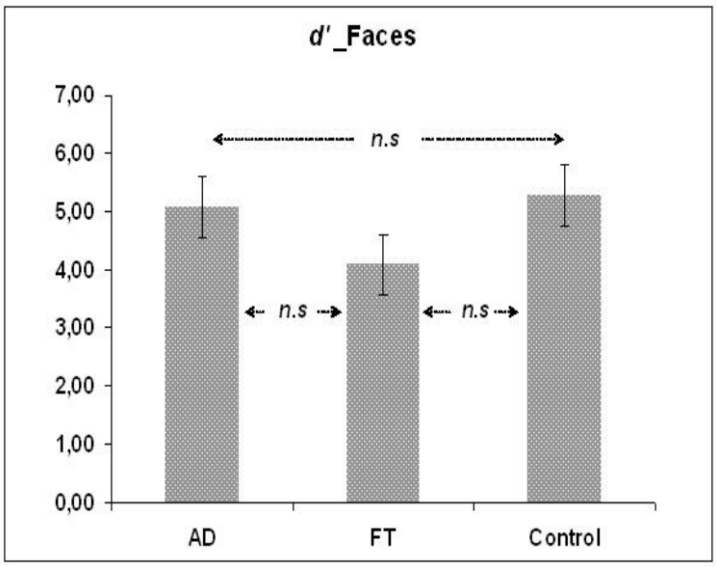

Figure 3. d'_{sd} values obtained from the discrimination of different non-emotional faces.

II. Overall Criterion values

The criterion measure corresponds to C_{sd}, derivable from the bias parameter k of the differencing model: $C_{sd} = K - d'/2$ (Macmillan & Creelman, 1991).

A general trend for heightened criteria values is apparent in both groups of patients, especially in the FTD sample. The difference regarding controls, considering mean C_{sd} values aggregated over all emotions, was significant for this later group (p = .006) but only marginally significant (taking a < 0.1 criterion for marginal significance) in the AD group (p = .069).

Looking separately at each emotion, FTD differ significantly (higher values) from Control subjects (p = .032) on *Sadness*. No significant differences among groups were found for *Fear*. As for *Joy*, FTD exhibit significantly higher values than both AD (p = .000) and Controls (p =.004), who do not differ statistically among themselves.

Table 2. Mean (and *SD*) C_{sd} values for the FTD, AD and Control groups

Groups		Sadness	Fear	Joy	***Non-emotional Faces***
FTD	Mean	1,04	0,67	0,74	*,13*
	(SD)	(0,36)	(0,47)	(0,77)	*(,43)*
AD	Mean	0,76	0,63	0,40	*,70*
	(SD)	(0,47)	(0,40)	(0,60)	*(,48)*
Controls	Mean	0,46	0,44	-0,08	*,67*
	(SD))	(0,47)	(0,61)	(0,38)	*(,25)*

Discussion

On the whole, both groups of patients exhibited a deficit in the discrimination of facial expressions of emotion regarding the controls, but not in the task involving the discrimination of different faces ("non-emotion" task). This concurs with the notion that losses in discrimination of facial emotion are not secondary, in any of these groups of patients, to general decline of facial processing abilities

FTD patients performed worse than AD patients when the intensities to discriminate were of *Sadness* and (less clearly) of *Fear*. FTD patients, in turn, performed better than AD patients when the intensities to discriminate were of *Joy*. Provisionally, this might suggest that differences in the pattern of sensitivity between the two groups of patients depend on such characteristics of emotion as valence (positive vs. negative; e.g. *joy vs. sadness*) or mixes of valence and activation (with *sadness* a low activation-negative valence emotion).

A general trend for higher criteria values as compared to controls (that is, for an attitude favoring a "same" response) is apparent in both samples of patients, especially in the FTD group for the emotions of *Sadness* and *Joy*. Given the usual understanding of criteria parameters, this might suggest that emotional discrimination can still be enhanced through criterion training.

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