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Comparison of Facial Emotion Recognition in Alzheimer's Dementia and Frontotemporal Dementia

Soheila Sadatrasoul[1] (MSc), Susan Alizadeh-Fard[1] (PhD)

1. Department of Psychology, Payam Noor University, Tehran, Iran

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Corresponding Author:
Soheila Sadatrasoul,
Department of Psychology,
Payam Noor University,
Tehran,
Iran
E-mail: ssadat60@gmail.com

Abstract

Introduction: The aim of this study was to compare the performances of facial emotion recognition in patients with Alzheimer's Dementia (AD) with patients with Frontotemporal Dementia (FTD) and healthy controls.

Method: The present study was a descriptive (causal- comparative) research in which patients with AD (n=50), patients with FTD (n=46) and healthy controls (n=50) were selected through convenience sampling. By means the Emotion Recognition Task (ERT), we assessed the recognition of facial emotional expression (happiness, anger, disgust, sadness, fear, surprise) across four intensities in these cohorts. Then, the two-way ANOVA test was used to analyze the data.

Results: In the assessment of task, for all emotions (other than happiness), the lowest scores were found in the FTD group. There were no significant differences on the happiness scores between groups. Patients with FTD performed lower than patients with AD and control on the emotions anger, disgust and sadness. Patients with AD had lower anger, disgust and sadness scores than the control group (p<0/001), but in fear and surprise, there were no significant differences between AD and FDT groups. However, they had lower scores in these emotions than the control group (p<0.05).

Conclusion: Our results revealed that emotion recognition deficits in both AD and FTD groups. The assessment of emotion recognition can improve the differential diagnosis of AD from FTD, and lead to better therapeutic interventions.

Keywords: Alzheimer's Dementia, Frontotemporal Dementia, Emotion Recognition, Emotion Recognition Task

Introduction

Dementia is the impairment of such an extent of cognitive and executive functions, understanding, remembering, and thinking that it disrupts a person's activities and daily life. These functions include memory, language skills, visual perception, problem solving, self-management, and the ability to focus and pay attention. Dementia is classified according to severity, ranging from the mildest stage, when it first begins to impair a person's ability to function, to the most severe stage [1]. Psychiatric and behavioral symptoms of dementia are reported to occur in roughly 90% of dementia patients [2].

There are different types of dementia; Alzheimer's Dementia (AD), levy body dementia, Frontotemporal Dementia (FTD), vascular dementia and mixed dementia. AD and FTD are the two most common forms of dementia [3].

AD is an irreversible, persistent disease of the brain, most often categorized under the umbrella term 'neurodegeneration'. It is a progressive illness in a sense that the symptoms associated with AD, the most current one being difficulty in remembering recent events, kick in steadily with the symptoms getting worse as time goes on, leading to the demise of the affected person as they eventually lose their bodily functions. Language problems, mood swings and disorientation are other symptoms which are usually associated with

alzheimer's [4]. AD is presently listed as the sixth leading cause of death in America and it is the most common dementia in the elderly [1].

'Frontotemporal' is a term that refers to the two sets of lobes (frontal and temporal) in the brain that are damaged in this type of dementia. FTD occurs when disease damages nerve cells in these lobes. It is the most prevalent type of dementia in people under the age of 65. Behavioral variant FTD (bvFTD), semantic dementia, and Primary Progressive Aphasia (PPA) are examples of FTD variants [5]. FTD is characterized by behavioral and language manifestations, and patients have relatively preserved memory, in contrast to AD [6], whereas the first symptoms of Alzheimer's disease are typically episodic memory and visuospatial impairments [4]. However, due to similar clinical symptoms, brain atrophy and cognitive domain impairments of AD and FTD are frequently misdiagnosed as the same, even with sophisticated clinical guidelines [7-9].

As previous research has demonstrated, behavioral and emotional changes may occur during the early stages of AD and FTD. Numerous studies emphasize the critical nature of social cognitive assessments in enhancing early diagnosis [10]. Social cognition is a broad and complex concept encompassing the psychological processes necessary for understanding and interacting socially with other people. It is frequently conceptualized in three hierarchical levels, ranging from perception and automatic attribution to comprehension and interpretation of social information [11].

Facial expressions of emotion can provide insight into another person's emotional state and can aid in predicting future behavior [12,13]. Additionally, because the deficiency in facial emotion recognition results from social misinterpretation, it results in difficulties with social behavior [14]. In fact, recognizing facial emotion is a critical component of social cognition [15]. It is a characteristic of interpersonal communication and a critical moderator of social behavior. The bvFTD can impair social and emotional functioning [16]. As previously stated, the inability to recognize facial emotion is a prominent and early developing feature of FTD [14-17]. Additionally, AD can impair emotional processing, affecting social communication [18]. However, when it comes to recognizing facial emotion in Alzheimer's disease, research on the recognition of emotional facial features in AD has produced inconsistent results, and there is no agreement on how AD can impair facial emotion recognition [19]. On the other hand, some studies have demonstrated the presence of deficits in facial emotion recognition in patients with FTD and AD, but the results were inconsistent [20].

Thus, the purpose of this study is to examine emotion recognition deficits across a range of emotions and emotional intensities using the ERT in patients with AD, patients with FTD, and controls, along with presenting a comparison. Specifically, our study will address the following question: What is the difference between facial emotion recognition in patients with FTD and patients with AD? Clarifying the nature and extent of facial emotion processing deficits in AD and FTD may provide new insights into these diseases' social and behavioral disturbances, which may aid in more precise differential diagnosis, disease-specific intervention, and treatment of these two dementia types.

Method

The present study used a descriptive (causal-comparative) approach. Patients diagnosed with AD and FTD referred to the Iranian Center for Neurological Research, the Neurology Clinic of Farhikhtegan Hospital, Dr. Karbalaie Memory Clinic, and the Dementia clinic Yadman in Tehran from October 2020 to March 2021 were included in the statistical research population. The sample size included 50 AD patients, 46 FTD patients, and 50 healthy controls. The control group was composed of individuals who shared the same age and education as the patients. The convenience sampling method was used to select participants who met the inclusion and exclusion criteria. Males and females aged 50 to 80 years were eligible if they were literate, had the appropriate cognitive ability to communicate with the researcher, and were at least three years post-diagnosis (in the case of AD and FTD groups). The exclusion criteria included the severity of the disease, which prevents participants from comprehending the purpose of the research and responding to the task, and physical and psychological issues that prevent participants from participating in the research and responding to the task. The following tool was used in this study:

Emotion Recognition Task (ERT): The ERT tool was used to assess emotion recognition abilities. The ERT is a computerized paradigm in which morphed video clips of facial emotional expressions at various intensities are presented and are labeled using six alternative forces (anger, disgust, fear, happiness, sadness, and surprise) choice response [21]. It enables real-time interactive morphing between two endpoint facial expressions (0% = neutral, and 100% = full-blown emotion) [22]. The video clips lasted between approximately 1 (40% emotion) and 3 seconds (100% emotion). The ERT version presented in this study includes morphs from neutral to four different intensities: 0–40%, 0–60%, 0–80%, and 0–100% emotional intensity (Figure 1). The video's frame count and duration were determined by the emotional intensity conveyed. The number of correctly labeled expressions per emotion and intensity (maximum = 4) was used to determine performance. Each emotion received a maximum score of 10 across the four intensities, for a total of 60 for the entire test. After obtaining participants' consent, each participant completed the task independently, in the same clinic but a separate room. A personal laptop was used to show each of the participants the images, and an examiner recorded the participants' responses.

The ERT began with a screen presenting the participant with task instructions (in the participants' native language). Three practice trials were conducted following the instructions and included facial expressions of angry, happy, and disgusted actors that were not included in the final stimulus set. After a brief pause to ensure the

participant understood the instructions and knew how to respond, the real test began. Unless otherwise specified, the instructions and practice trials were repeated. Mouse clicks were used to initiate responses. If participants were unsure how to operate the computer mouse or were unable to do so, the examiner assisted them by asking which label they felt was the most appropriate (and clicked the given response if needed). The test was terminated if the participant continued to struggle to comprehend the test instructions or was unsure how to respond after repeated instructions. Each test performance lasted approximately 15 minutes and took place in the afternoon (minimum performance time of seven minutes and a maximum of 34 minutes). While most participants had no difficulty performing the test, four individuals refused to complete it and were thus excluded from the study. The participants were informed of all ethical considerations, including the study's objectives, their right to withdraw from the study at any time, and the confidentiality of their data. The data were analyzed using SPSS-24 using the mean, standard deviation, and two-way ANOVA model.

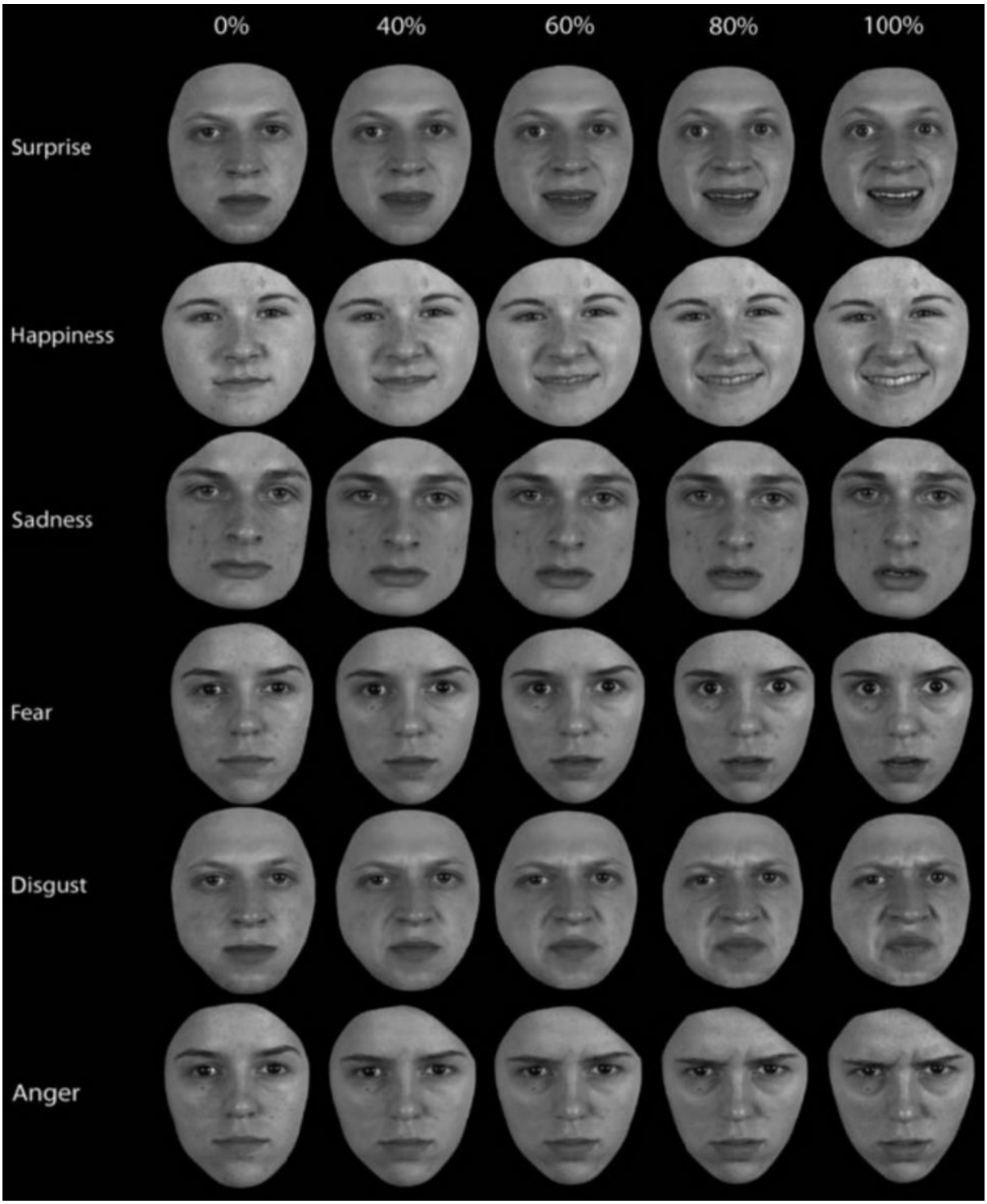

Figure 1. Examples of facial expressions of the ERT.

Results

This study enrolled a total of 146 participants, whose demographic characteristics are summarized in Table 1. The analysis revealed no statistically significant difference between groups.

Afterward, the sample group's ERT score was calculated. The mean and standard deviations for various diagnosis groups and emotions are summarized in Table 2.

The normality distribution of all data was determined using the Kolmogorov-Smirnov test, which revealed that all score distributions were normal. The two-way model ANOVA was used to analyze the differences between each variable. Prior to performing ANOVA, Mauchly's test was performed. Mauchly's test revealed that the test was insignificant for all variables. As a result, the variances within groups were equal. Table 3 highlights the results of the two-way ANOVA.

As stated in Table 3, significant differences in groups and interactions between groups and emotions existed. Thus, one-way ANOVA and Bonferroni tests were used to determine the groups and their interactions with each emotion, the results of which are presented in the tables below.

As shown in Tables 4 and 5, there were no significant differences in ERT scores between the AD and FTD groups, but both groups differ significantly from the control group.

As presented in Tables 6 and 7, there were no statistically significant differences in ERT scores between different groups concerning happiness. On the other hand, other emotions exhibit several distinctions. As it can be seen, there were significant differences in ERT scores for anger, disgust, and sadness between the AD, FTD, and control groups. There were no significant differences in ERT scores between the AD and FTD groups in fear and surprise, but both groups demonstrated significant differences compared to the control group.

Table 1. Demographic Characteristics of Participants (N = 146)

Demographics	
Age	72.65 (± 4.09)
Sex	
Male	70 (48%)
Female	76 (52%)
Education	
Under diploma	45 (31%)
Diploma	62 (42%)
Higher education	39 (27%)

Table 2. Means and Standard Deviations of Groups and Emotions

Groups	**Emotions**					
	happiness	anger	disgust	sadness	fear	surprise
Control	3.04 (.54)	2.90 (.74)	2.28 (.50)	1.82 (.74)	1.74 (.80)	1.38 (.56)
AD	2.80 (.83)	2.12 (.32)	1.34 (.34)	1.04 (.57)	.88 (.63)	.70 (.28)
FTD	2.60 (.41)	1.18 (.30)	.90 (.36)	.54 (.23)	.50 (.25)	.42 (.27)

Table 3. Results of Within-subjects Effects for Different Groups and Emotions

	df	**F**	**P**
Groups	2	13.26	0.001**
Emotions	5	1.47	0.07
Groups × emotions	10	1.93	0.04*

Table 4. Results of Within-subjects Effects in Different Groups

	N	**Mean**	**Std. Deviation**	**F**	**P**
Control	50	2.25	.56	13.26	0.001
AD	50	1.48	.33		
FTD	46	1.02	.07		

Table 5. Results of Bonferroni Test for Comparing Paired Groups

	Mean difference	**P**
AD, FTD	0.14	0.07
AD, control	0.24	0.11
FTD, control	0.38	0.24

Table 6. Results of Within-subjects Contrasts for Different Groups in Each Emotion

		N	Mean	Std. Deviation	F	P
Happiness	Control	50	3.40	.54	2.21	0.152
	AD	50	2.80	.83		
	FTD	46	2.60	.41		
Anger	Control	50	2.90	.74	14.85	0.001
	AD	50	2.12	.32		
	FTD	46	1.18	.30		
Disgust	Control	50	2.28	.50	14.90	0.001
	AD	50	1.34	.34		
	FTD	46	.90	.36		
Sadness	cControl	50	1.82	.74	7.63	0.007
	AD	50	1.04	.57		
	FTD	46	.54	.23		
Fear	Control	50	1.74	.80	6.58	0.012
	AD	50	.88	.63		
	FTD	46	.50	.25		
surprise	Control	50	1.38	.56	5.40	0.021
	AD	50	.70	.28		
	FTD	46	.42	.27		

Table 7. Results of Bonferroni Test for Comparing Paired Groups in Each Emotion

		Mean difference	P
Happiness	AD, FTD	0.14	0.07
	AD, control	0.24	0.11
	FTD, control	0.38	0.24
Anger	AD, FTD	0.94	0.01*
	AD, control	0.78	0.02*
	FTD, control	1.72	0.001*
Disgust	AD, FTD	0.44	0.04*
	AD, control	0.93	0.02*
	FTD, control	1.36	0.001*
Sadness	AD, FTD	0.50	0.04*
	AD, control	0.76	0.03*
	FTD, control	1.28	0.001*
Fear	AD, FTD	0.37	0.21
	AD, control	0.86	0.02*
	FTD, control	1.24	0.001*
Surprise	AD, FTD	0.28	0.19
	AD, control	0.68	0.03*
	FTD, control	0.96	0.01*

Discussion

The findings of this study concerning patients with FTD performing poorly across all emotions are consistent with the results of several studies indicating that FTD patients demonstrate significant impairments in emotion recognition [14, 20, 21, 23, 24]. Other findings of emotion recognition deficits in patients with AD are consistent with several studies indicating that patients with AD exhibit impaired emotion recognition [19, 20, 25, 26].

Total task assessment scores were observed to be lower in the FTD group than in the AD group. Conversely, the control group demonstrated the highest performance. For all emotions (except happiness), patients with FTD had lower sub-scores than patients with AD. As a result, patients with AD outperformed patients with FTD on all tasks. It is reasonable to hypothesize that patients with AD will gradually lose their ability to process affective information, particularly their ability to recognize facial expressions of emotion [2].

In emotions of anger, disgust, and sadness, patients with FTD performed worse than patients with AD and control [14]. The inability of patients with FTD to recognize negative emotions is consistent with atrophic changes in FTD [27]. Atrophy of the insula and orbitofrontal cortex, in particular, may result in relatively specific deficits in anger and disgust [28, 29].

In emotions of fear and surprise, there was no difference in performance between the FTD and AD groups. However, their fear and surprise scores were lower than those of the control group. The FTD and AD groups did

not differ significantly in terms of happiness from the control group. This finding implies that patients with FTD and AD retain the capacity to recognize happiness. Bora et al. [14] hypothesize that the relative preservation of happiness recognition may be related to a ceiling effect. This finding is consistent with several studies demonstrating preservation of the ability to identify happy facial expressions [14, 21, 30], and it contradicts studies demonstrating a deficit [30, 31].

We also observed significant differences in emotion scores regardless of clinical status, with higher scores for happiness and anger consistent with the findings of other studies [20, 21], lower scores for disgust, sadness, and fear, and highest scores for surprise. These findings indicated that all participants performed best when recognizing happiness and anger and inadequately when recognizing surprise. The high happiness scores in all three groups, their aptitude in recognizing this emotion, and the significant difference between this emotion and other emotions may corroborate the findings of other studies suggesting that recognition of this emotion in AD and FTD patients is related to a ceiling effect [14, 32].

The results indicated that the deficits in facial emotion recognition were more pronounced in FTD than in AD. These findings lend support to the concept of social cognitive impairment having relative characteristics to FTD. Incorporating social cognitive deficits into neuropsychological criteria and combining them with other cognitive and clinical characteristics can aid in differentiating FTD from AD [14].

In comparison to previous research in the field of facial emotion recognition in AD and FTD, the present study's strength is the use of ERT to quantify and compare facial emotion recognition in AD and FTD. The use of patient cohorts from several different neurological centers may have introduced some heterogeneity into our patient samples, limiting the generalizability of our findings. Thus, it is recommended that future research in this area include increasing and expanding group samples.

Conclusion

Our study establishes the presence of facial emotion recognition deficits in patients with FTD and AD via ERT. The ERT distinguished patients with FTD, AD, and a control group. It was concluded from the study findings that ERT is critical in providing more accurate neurological assessments to aid in the differential diagnosis of these two types of dementia and that it could serve as a potential clinical endpoint in upcoming FTD and AD therapeutic trials.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Ethical Approval

All authors adhered strictly to all ethical considerations, including informed consent, the right to withdraw from research, confidentiality, respect for privacy, beneficence in conducting research, plagiarism, data fabrication or falsification, duplication of publication or submission, and redundancy, throughout the study's preparation, implementation, and the development of the current manuscript.

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