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Recognition of facial emotions in individuals with a Stroke

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Abstract

Background: *Many stroke patients have significant difficulties recognizing facial expressions. This kind of impairment can have profound effect on social functioning.*

Objectives: *To assess the degree of difficulty of stroke patients in the recognition of facial emotional expressions and their possible relation with lesion laterality location, gender, injury severity, and functional capacity in activities of daily living.*

Methods: *An observational study of 48 patients admitted to the Brain Injury Unit of Aita Menni Hospital (Guipúzcoa) with a diagnosis of stroke. Patients were evaluated using the Emotion Recognition Scale for Patients with Schizophrenia (PERE), National Institute of Health Stroke Scale (NIHSS), Barthel Index, and FIM / FAM functional independence scale.*

Results: *Patients recognized 65.73% of the photographs. There were no significant differences in the recognition of emotions in patients with stroke in the right or left hemisphere or between male and female patients. There is a direct relationship between the degree of injury severity and the difficulty in the recognition of emotions. Conclusions: Stroke causes a severe difficulty in the ability to recognize emotions in faces. This difficulty seems to be positively related to stroke severity but not to lesion laterality or gender.*

Keywords:

Stroke. Laterality. Emotion recognition of faces. Severity. Gender.

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Introduction

Stroke is a growing health and social problem: it is the third leading cause of death and the first cause of disability in developed countries (1-3). In Spain, incidence of stroke is 120 to 350 of 100,000 per year (4, 5); 45% of surviving patients with stroke displayed moderate or severe disability three months later (6); it is estimated that 200,000 people have a significant functional disability secondary to stroke (7).

Stroke causes a wide range of impairments that can be classified as motor and sensory deficit on the one side, and mental changes on the other. The latter have a profound impact on social interaction; emotion recognition of faces is one among many of the psychological processes needed to maintain successful social relationships (8). Forty percent of patients with moderate or severe brain lesions have problems recognizing emotions in faces (9). The relationship between emotion recognition on the one hand, and social participation (10) or marital satisfaction (11) is well documented.

Yuvaraj published a review of emotion recognition in stroke where it was determined the special and greater contribution of the right hemisphere (3). Due to the relevance of the publication, a more detailed analysis of this review can be summarized as follows: out of 35 studies included in the review, one is a single case study (12), another includes only subjects under 24 months of age (13) and two different publications seems to use the same dataset (14); six studies compare right brain damage (RBD) with normal controls (11, 15-19) and in all six studies patients perform worse than controls; two studies include samples with focal lesions or subcortical lesions that are not classified as right or left hemisphere lesions (20, 21); out of the remaining 24 studies, 15 show a poorer recognition of every single emotion in RBD compared with left brain damage (LBD) and controls (22-36), 5 studies only find poorer recognition in some negative emotions (37-41), 3 studies find no difference between the three groups (RBD, LBD and controls) (42-44) and one study showed poorer recognition of patients with LBD (45).

These results, together with more recent published evidence (10, 46, 47), suggest that both hemispheres seem to contribute to the recognition of emotions in faces, with a greater role of the right hemisphere.

Due to the fact that the literature on these issues is far from conclusive (38, 46, 48, 49), this study has one main hypothesis that focuses on the issue of the relation between emotion recognition in faces and laterality of the lesion: patients with right brain damage will show greater difficulties in the recognition of emotions than patients with left brain damage. A secondary hypothesis includes that subjects with LBD will show better recognition of positive rather than negative emotions, that is known as the valence hypothesis. Finally, it explores the relation on facial emotion recognition and gender, injury severity, and functional capacity in activities of daily living.

Related to these hypotheses, this study aims to assess facial emotion recognition of patients with severe stroke, its accuracy and its relationship with variables such as hemispheric localization, emotional valence, gender, and injury severity.

Methods

Participants

Forty-eight subjects participated in an observational study with a single assessment point. Participants were in-patients of the Brain Injury Unit of Aita Menni Hospital (Spain) with a diagnosis of stroke. Patients admitted to this unit have important deficits related to multiple aspects of their functionality (motor, sensorial, language, cognition, or social behavior) and a high degree of dependence.

Sample selection criteria included: (a) over 18 years old, (b) suffered a stroke (diagnosed by CT or MRI), (c) were receiving rehabilitation treatment in the Brain Injury Unit of Aita Menni Hospital (Spain), (d) had preserved communication skills (comprehension and expression), (e) had preserved vision and were able to complete the questionnaires, and (f) signed an informed consent form. Patients were excluded if they had (a) previous neurologic or psychiatric pathology, (b) drug abuse, or (c) bilateral injury.

Procedure

Informed consent form included full explanations about the objectives of the study, the data collection procedure, the willfulness of their participation, and the anonymous use of the collected data. Participants did not receive compensation for their participation in the study. Most of the patients were admitted 1 to 5 weeks after the stroke.

Thirty-two (66.7%) of the participants included were men, twenty-five (52.08%) showed stroke in the left hemisphere, and the mean age was 57.9±13.23 years with a range from 22 to 87.

Instruments

Clinical data and outcomes related with the study variables were collected using the following psychometric assessment tools:

Emotion Recognition Assessment Test (ERAT) (50) was used to assess the main variable of this study. This test is composed of 56 pictures of different faces that represent one basic emotion. The emotions included: neutral, happiness, sadness, anger, disgust, fear, and surprise. The participant had to identify the emotion represented in the photograph from the 7 possible options. There was no time limit to complete the test.

To avoid possible bias related to the gender of the actors presented in the photographs, the test had the same number of pictures of male and female actors; total score ranges from 0 to 56 (one point for each correct answer) and a subscore for each emotion (0-8). Higher scores meant better emotion recognition. The original validation study found accuracy higher than 89% in the control sample. Mean total score was 53.95±0.07. Happiness was the emotion with highest scores (7.88±0.03) and fear was the emotion that showed lowest scores (7.37±0.11). The scale was originally developed to test the ability to recognize facial emotions in schizophrenic patients. It is a very simple tool freely available from the website www.proyectoscores.es/pere.php.

Barthel Index for Activities of Daily Living (ADL) (51) and the FIM/FAM (The Functional Independence Measure and Functional Assessment Measure) (52) were used to asses patients functionality. Barthel Index has 10 items that assess patient's functional independence in activities of daily living: feeding, bathing, grooming, dressing, bowel control, bladder control, toilet use, transfers, mobility, and use of stairs. Total score ranges from 100 (total independence) to 0 (total dependence). The index does not require cultural or language adaptation because it is based on behavioral observation (53). It can be answered by a clinician or by a caregiver. Barthel index shows significant correlations with other scales that assess activities of daily living, such as the Katz index (54). This index captures changes in the functional state of stroke patients or patients that are in the process of rehabilitation (55).

FIM/FAM is a functional scale composed by 18 items: 13 items evaluate the motor capacity, and 5 items measure cognitive functioning. Total score ranges from 18 (total dependence) to 126 (total independence). It can be answered via clinical observation or by the information provided by the main caregiver. Psychometric studies show high internal consistency. The instrument provides a good estimate of the type and amount of care required (56).

National Institute of Health Stroke Scale, NIHSS (57). This scale has 11 items that assess cortical functions, motor functioning, sensorial capacities, coordination, and language. The score ranges from 0 to 42 points. Higher scores indicate higher severity and a worse prognostic of recovery. This scale has been validated and adapted to Spanish context (58).

Each participant was evaluated independently by a postdoctoral psychologist specifically trained in the correct use of the assessment tools. This evaluation took place in the same center and took about XX minutes. Data was collected from September 2017 to May 2018.

Statistical analysis

Categorical variables are represented by frequencies and percentages and continuous variables by means and typical deviations. Comparisons by means were performed using the Student´s t-test

Table 1. Sociodemographic and injury characteristics of the sample

	TOTAL (n=48)	Male (n=32)	Female (n=16)	P value	Left (n=25)	Right (n=23)	P value
Age, mean (SD)	57.90 (13.23)	57.84 (11.59)	58 (16,44)	.970	58.32 (15.48)	57.43 (10.58)	.820
Injury location, frequency (%)							
Left	25 (52.1%)	17 (53.1)	8 (50%)		-	-	
Right	23 (47.9%)	15 (46,9)	8 (50%)	.540	-	-	
NIHSS, mean (SD)	11.21 (4.3)	10.19 (3.65)	13.25 (4.87)	.019	10.64 (3.81)	11. 82 (4.79)	.346
Barthel, mean (SD)	32.71 (23.54)	34.22 (22.82)	29.69 (25.39)	.535	29.2 (22.43)	36.52 (24.6)	.287
FIM/FAM, mean (SD)	109.98 (30.99)	116.53 (25.13)	96.88 (37.81)	.037	109.72 (29.21)	110.26 (33.47)	.953

for the independent samples and Chi square for the comparisons of frequencies.

The hypotheses of the study was tested using an ANCOVA statistic including the following co-variables: the National Institute of Health Stroke Scale, gender, laterality of stroke, and age (59). Bivariate correlations were performed with the Pearson correlation coefficient and the Pearson determination coefficient.

All the statistical analyses were run in an independent lab with the statistical software SPSS v.21.

Results

Mean score and standard deviation for the stroke sample in the emotion recognition test (ERAT) was 36.81±8.18 (that is an accuracy of recognition of 65.73%); highest accuracy was obtained for happiness (7.45±1; 93.22%) and fear obtained poorest recognition (2.06±1.8; 25.78%). Mean FIM/FAM scores and Barthel scores were 109.97±30.99 and 32.70±23.54. Mean injury severity of the stroke sample (NIHSS) was 11.20±4.3. In this sample women had more severe strokes than men (t(1, 46)=-2.44; p=.019) and they consequently showed higher levels on dependency (t(1, 46)=2.15; p=.037). Rest of comparisons failed to show significant differences (Table 1).

Laterality

Patients with LBD failed to show different scores in emotion recognition than RBD patients (F(1, 46)=.613; p=.438). There were no differences when each of the emotions were studied separately (Table 2).

Emotional valence

Patients with RBD tend to show a better recognition of positive emotions but the differences fail to be statistically significant (F(1, 46)=2.704; p=.107). The rest of the comparisons are not significant and do not show a definite pattern. (Table 2)

Table 2. Comparisons between groups in the Emotion Recognition Assessment Test (ERAT).

	TOTAL (n=48)	Male (n=32)	Female (n=16)	P value	Left (n=25)	Right (n=23)	P value
ERAT, mean (SD)	36.81 (8.18)	37.96 (7)	34.5 (9.98)	.631	36.40 (7.64)	37.26 (8.87)	.438
Hapyness	7.45 (1)	7.53 (0.87)	7.31 (1.25)	.646	7.24 (1.09)	7.70 (0.87)	.107
Sadness	4.08 (2.14)	4 (2.09)	4.25 (2.29)	.539	3.76 (2.42)	4.43 (1.77)	.261
Fear	2.06 (1.80)	1.84 (1.78)	2.5 (1.82)	.049	2.12 (1.94)	2 (1.67)	.961
Disgust	5.7 (2.21)	6.03 (2.16)	5.06 (2.23)	.524	5.84 (1.93)	5.57 (2.51)	.894
Anger	5.66 (2.05)	6.15 (1.64)	4.66 (2.05)	.085	5.64 (2.17)	5.7 (1.96)	.709
Surprise	5.51 (2.53)	6.15 (2.20)	4.25 (2.74)	.088	5.56 (2.56)	5.48 (2.55)	.796
Neutral	6.31 (2.22)	6.25 (2.21)	6.43 (2.30)	.747	6.24(2.35)	6.39 (2.12)	.831

Gender

Men show higher accuracy in emotion recognition (ERAT) than women, but when severity, laterality, and age are taken into account (ANCOVA) the significance of those differences vanish ($F(1, 46)=.234$; $p=.631$). It is worth mentioning the recognition of fear: women show higher accuracy despite the fact that in general, patients show low scores ($F(1,46)=4.24$; $p=.049$) (Table 2).

Injury severity

Pearson correlation analysis reveals an inverse relationship between severity (NIHSS) and facial emotion recognition ($r=-.445$; $n=48$; $p=.002$) (Table 3 and Fig. 1).

Functional outcome

Functional outcome (FIM/FAM) shows a positive correlation with emotion recognition (ERAT) ($r=-.435$; $n=48$; $p=.002$) (Fig. 1) where Individuals with better functional capacity have better emotional recognition. The results with the Barthel index point in the same direction without achieving statistical significance (Table 3).

Table 3. Correlations results between facial emotion recognition (ERAT) and injury severity (NIHSS), functional outcomes (FIM/FAM and Barthel scale).

	ERAT r (P value)
NIHSS	-.445 (.002)
FIM/FAM	.435 (.002)
Barthel	.279 (.054)

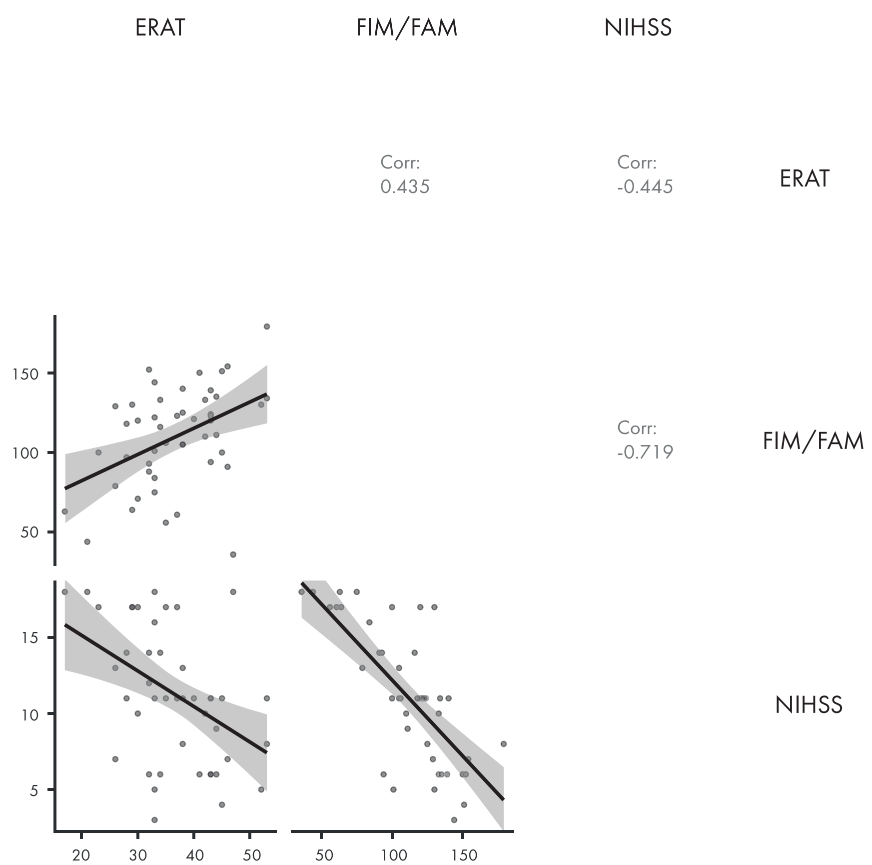

Figure 1. Correlation between facial emotion recognition (ERAT), severity (NIHSS) and functionality (FIM/FAM).

Discussion

This sample of stroke patients showed a great difficulty with facial emotion recognition tasks. Accuracy of recognition in ERAT was far lower than in the sample of healthy subjects used to validate the scale (50). The results are very scattered and suggest a greater heterogeneity in patients than in healthy control subjects. These results do not confirm the theory of hemispheric specialization of emotion highlighted by Yuvaraj in his review (3); they suggest that both hemispheres participate in facial emotion recognition, which is a conclusion previously proposed on the basis of similar findings (38, 46, 60). Neither seems that there is a hemispheric specialization according to the emotional valence of facial expressions.

In regard to gender and emotion recognition, there are only differences in specific emotions: women are better at identifying fear despite the greater severity of their lesions. Other variables such as stroke severity or functionality show a close correlation with emotion recognition: less severity and higher functionality predict a better facial recognition. In this study severity is more closely correlated to facial recognition than laterality.

An unexpected finding in this study relates to gender. Men included in the study doubled the number of women (32/16) and the mean severity of women was higher than that of men. These findings are compatible with others reported in Spain (61) and suggest a potential gender discrimination in the access to rehabilitation services and in the referral process.

We acknowledge that this study may have several limitations. Firstly, these results are based in a small convenience sample that presents a severe stroke severity. This can affect the possibility of generalizing them to other contexts or clinical situations. Secondly, the lack of a control group is an important limitation in order to establish a causal inference more accurately. Despite the limitations, these results suggest that both hemispheres participate in facial emotion recognition and that stroke severity is far more influential in that ability, than laterality. There is no information about the specific role played by each of the hemispheres and this is certainly an important and pending question. Faced with the lack of consensus on the issue of localization of emotional recognition, it is necessary to ask whether the right questions are being asked in the pursuit of a better understanding of the relationship between brain function and emotion recognition. The type of general questions we are asking, relation of emotion recognition with the side of the lesion might be as general as to ask about the relation between cognitive function or thought generation and laterality. In the world of cognition, more discrete variables such as "language comprehension" or "immediate memory" have proved more useful, both in the generation of cognitive models and in the neuroanatomical studies. In the realm of cognitive functions, we are aware that there are constructs, such as social cognition or executive functions, that are still too complex to look for precise localizations in the brain. This may well be the case with emotion recognition. Emotion recognition refers to many different types of emotions (basic and secondary is a popular taxonomy nowadays) and to a whole sequence of processes (perception of facial features, pattern recognition, use of stored information, naming of the recognized emotion, etc.) carried out at a conscious or unconscious level (62). In any case, participants of this study show great difficulties in emotion recognition and we need a detailed account and a better understanding of these difficulties in order to improve their social functioning and their families' quality of life.

Statements

Acknowledgement
None.

Statement of Ethics

All participants signed an informed consent form. The study protocol was approved by the Ethics Committee of Sisters Hospitallers. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Disclosure Statement

The authors have no conflicts of interest to declare.

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Author Contributions

NM designed the study, participated in data collection and in the manuscript redaction. JIQ contributed to the discussion and reviewed and edited the manuscript. EGF performed the statistical analysis and reviewed and edited the manuscript. EGF are the guarantors of this work and as such, had full access to all of the data. EGF assumes responsibility for the integrity of the data and the accuracy of the data analysis. All authors read and approved the final manuscript.

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