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ORIGINAL RESEARCH

Impaired Visual Emotion Recognition After Minor Ischemic Stroke

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Abstract

Objective: To assess the prevalence of impaired visual emotion recognition in patients who have experienced a minor ischemic stroke in the subacute phase and to determine associated factors of impaired visual emotion recognition.

Design: A prospective observational study.

Setting: Stroke unit of a teaching hospital.

Participants: Patients with minor ischemic stroke (N=112).

Interventions: Not applicable.

Main Outcome Measures: Patients with minor stroke underwent a neuropsychological assessment in the subacute phase for visual emotion recognition by the Ekman 60 Faces Test and for general cognition. Univariable linear regression analyses were performed to identify associated factors of emotion recognition impairment.

Results: In 112 minor stroke patients, we found a prevalence of 25% of impaired visual emotion recognition. This was significantly correlated with impaired general cognition. Nevertheless, 10.9% of patients with normal general cognition still had impaired emotion recognition. Mood was negatively associated. Stroke localization, hemisphere side, and sex were not associated.

Conclusion: Impaired visual emotion recognition is found in about one-quarter of patients with minor ischemic stroke.

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Worldwide, 15 million people experience a stroke each year. Over the past decades, major improvements have been made concerning acute stroke treatment, resulting in better poststroke survival rates. As a consequence, more patients are directly discharged home after hospital admission. A substantial proportion of them experience a minor stroke and are generally patients with mild symptoms and a short-term, good functional outcome.[1,2] Nevertheless, up to 70% of the minor stroke patients who are directly discharged home still have cognitive sequalae, including impairments in speed of information processing, attention, memory, visuospatial functioning, executive functioning, language, and mental flexibility.[3,4] Although these impairments are more subtle in contrast to patients with major stroke, they can nevertheless have serious effects on functional recovery, quality of life, and social participation.[5,6]

One aspect of cognition is social cognition. Impairment in social cognition after a stroke and its effects have gained growing interest for both clinician and patients.[7-10] In the neuropsychological literature, social cognition is defined as “the ability to construct representations of the relation between oneself and others and to use those representations flexibly to guide social behavior”.[11]

In the domain of social cognition, an integrated model based on different models[12-14] is used to distinguish 3 levels of assumption: (1) social perception and automatic attribution, (2) understanding and interpretation of social information, and (3) reason and regulate. One part of level 1 is emotion recognition, including visual emotion recognition. Adolphs described the recognition of visual

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emotions as a central component of social cognition.[11,15] Emotion recognition plays a pivotal role in our daily life, in interpersonal communication, and in community integration.[16-19]

Previous studies in stroke patients have shown an association between poor emotion recognition, low social participation, and reduced quality of life.[20] Starkstein et al[21] found a prevalence of emotional aprosody in 49% of patients with acute stroke (<10d). Patients with aprosody showed a significantly higher frequency of incorrect performances on a facial emotion recognition task, suggesting that impaired visual emotion recognition is prevalent after a stroke. More recently, Nijsse et al[22] found that patients, 81.7% of whom experienced a mild stroke, scored lower on social cognitive tasks (including impaired visual emotion recognition) after a post stroke interval of 3 to 4 years, compared with a control group. Aben et al recently showed that 33.5% of a group of patients who experienced a stroke had impaired (visual) emotion recognition.[23] Thus far, the prevalence of impaired visual emotion recognition in the subacute phase among patients with a minor stroke is not clear. This group in particular is of interest; because these patients will not receive specific aftercare or rehabilitation, their symptoms and impairments in emotion recognition might be easily overlooked.

Given the possible consequences for daily social functioning, this can have important clinical implications for medical follow-up. The aims of the present study were to assess the prevalence of impaired visual emotion recognition in the subacute phase and to study its determinants.

Methods

Study design and patients

This study was a prospective observational study in all patients with a minor ischemic stroke who were admitted to the stroke unit of the Medisch Spectrum Twente (MST), Enschede, The Netherlands. The inclusion criteria were patients who were directly discharged home after hospital admission, age of 18 years or older, and clinical diagnosis of ischemic stroke confirmed by brain computed tomography or magnetic resonance imaging. Ischemic stroke was defined as focal neurological deficit of presumed vascular origin lasting 24 hours or more with acute brain imaging showing typical signs of recent brain infarction or no abnormalities in this early stage, or focal neurological deficit lasting less than 24 hours with typical signs of recent brain infarction on acute brain imaging. Minor stroke was selected based on National Institutes of Health Stroke Scale (NIHSS) score of 3 or lower at discharge and modified Rankin Scale (mRS) score of 2 or less at inclusion 6 weeks postonset.[1,2,24]

The exclusion criteria for the study were presence of psychiatric disease diagnosed according to the Diagnostic and Statistical Manual of Mental Disorders criteria as determined by a psychiatrist, language barrier, evidence for a language disorder, previous neurological disorder, not discharged home, receiving rehabilitation, or inability to give informed consent.

List of abbreviations:

FEEST	**Facial Expression of Emotion: Stimuli and Tests**
MoCA	**Montreal Cognitive Assessment**
mRS	**modified Rankin Scale**
NIHSS	**National Institutes of Health Stroke Scale**
PHQ-4	**Patient Health Questionnaire-4**

Procedure

Data on demographics, stroke severity and characteristics, imaging findings, and vascular history and risk factors were derived from the Enschede Stroke Service Database. Patients from the database who experienced a stroke in the period from December 2017 to October 2018 were screened for eligibility (for the patient flow see fig 1). Patients were assessed after 6 weeks, from January to November 2018. Six weeks is considered the subacute phase in recovery after a stroke.[25]

Measures

Visual emotion recognition

Visual emotion recognition was assessed by the Ekman 60 Faces Test, a part of the Facial Expressions of Emotion: Stimuli and Tests (FEEST).[26] Patients were shown 60 static pictures of faces with expressions of emotion on a computer screen. They chose the word from a list with 6 emotions (happiness, sadness, anger, fear, surprise, and disgust) that best described the emotion expressed by the image shown. Scores were interpreted according to the new Dutch standards.[27] Impairment was defined as a normal score at the fifth percentile or lower.

Cognition

The Montreal Cognitive Assessment (MoCA) was used to screen for cognitive deficits.[28] The MoCA was developed for the screening of mild cognitive impairments. It measures 8 cognitive domains: visuospatial and executive functions, denomination, memory, attention, mental flexibility, abstraction, language, and orientation. The score is derived by adding the points of each successfully completed task and ranges from 0 to 30 points.

Mood

Mood was assessed with the Patient Health Questionnaire-4 (PHQ-4), an ultrashort self-report measurement designed to measure depressive symptoms.[29] Four core symptoms of depression and anxiety are used in the PHQ-4: loss of interest, depressed mood, feeling anxious, and difficultly stopping or controlling worrying. The total scores for the PHQ-4 range from 0 to 6 for each of the 2 subscales, with a cutoff score of 3 indicating depression or an anxiety disorder.

All measures had good reliability and validity.[15,30−32]

Statistical analyses

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 25.0. *P* values less than .05 were considered statistically significant. The primary outcome measure was impaired emotion recognition. To investigate whether MoCA was associated with impaired emotion recognition as a continuous variable, we performed a univariable linear regression analysis. When FEEST was divided into impaired vs not impaired, the association with continuous variables was investigated with *t* tests or Mann-Whitney *U* tests, as appropriate. For categorical variables such as mood, sex, localization, laterality, and education the association with emotion recognition impairment was analyzed using chi-squared tests.

Ethics statement

The study was approved by the Medical Ethic Committee of the MSTMedisch Spectrum Twente. All participants provided written informed consent and all data were analyzed anonymously.

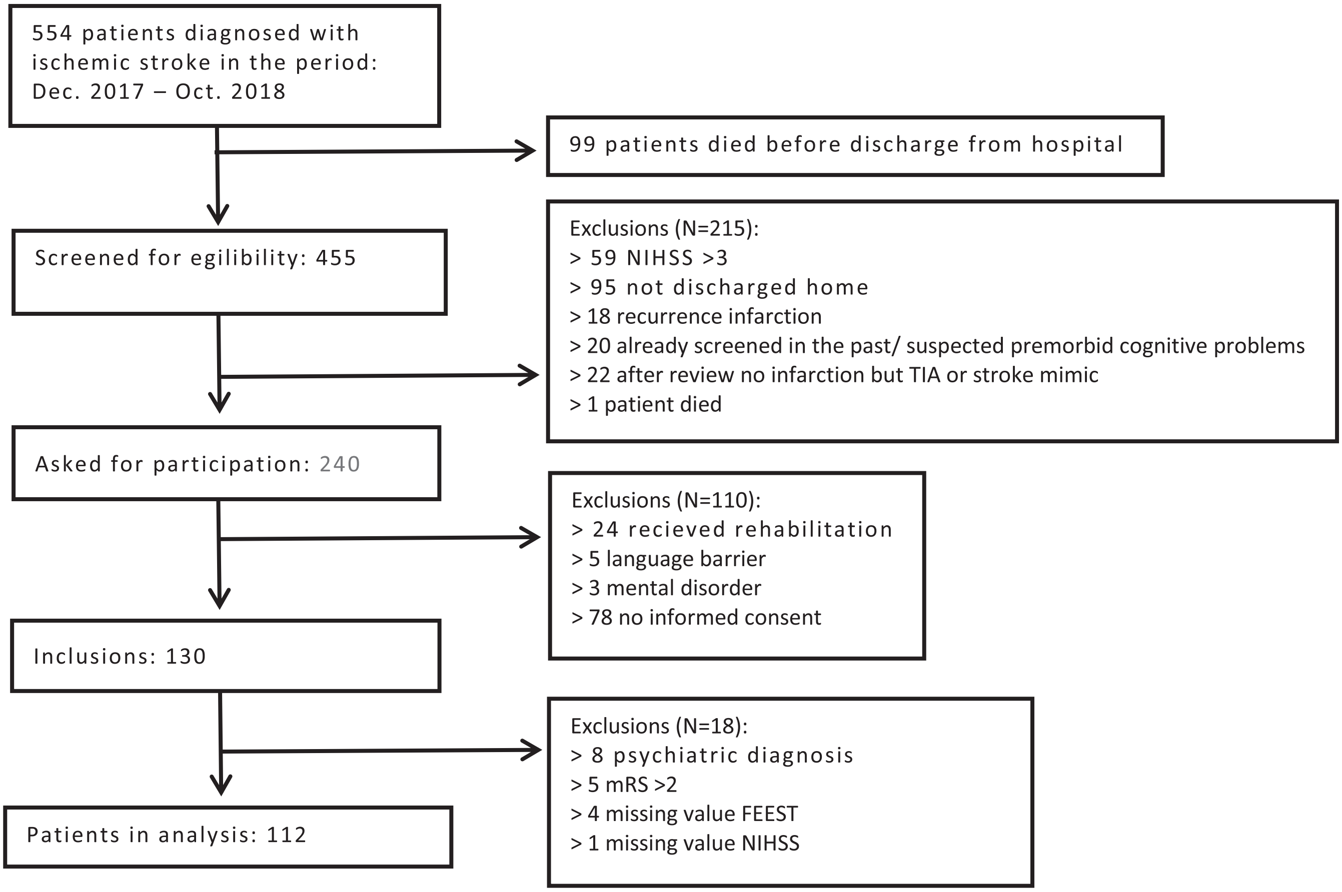

Fig 1 Flowchart of patients in the study. Patients on the left side were eligible for screening, participation, inclusion, or analysis. Patients on the right side dropped out or were excluded. A total of 112 patients were ultimately included in the analysis.

Results

During the period from December 2017 to October 2018, 554 hospitalized patients were diagnosed with an ischemic stroke. Of these, 99 patients died during hospitalization and 445 patients were screened for eligibility. Two hundred fifteen patients dropped out for the following reasons: NIHSS score greater than 3, not discharged home, stroke recurrence, suspected premorbid cognitive problems, review by an independent neurologist determined that there was no ischemic stroke but rather a transient ischemic attack or stroke mimic, and death (see for flowchart in fig 1). A total of 240 patients were included in the study; 110 of these dropped out because they received rehabilitation, experienced a language barrier, had a mental disorder, or provided no informed consent. Eighteen patients were excluded because they received a psychiatric diagnosis, and 4 others had an mRS score greater than 2 or missing values. The results of a total of 112 patients were analyzed.

Primary outcome

The prevalence of impaired visual emotion recognition in the subacute stroke phase was 25%. General cognition was impaired in 50.9% of the patients (table 1).

When the FEEST was divided into impaired vs not impaired emotion recognition (table 2), the impaired group did not differ significantly from the unimpaired group for the variables of age, sex, education, mRS score, NIHSS score, laterality, or stroke localization (see table 2). MoCA scores were lower for impaired patients; patients with impaired visual emotion recognition had a mean MoCA score of 23.0 (SD, 3.3), whereas the MoCA score for patients with a normal score on the FEEST was 25.1 (SD, 3.3) (P=.006). Mood, assessed with the PHQ-4, was negatively related to the FEEST. Patients with an impaired FEEST appear to have a significantly better mood (P=.046).

Univariate linear regression analysis showed a significant relationship between scores on impaired emotion recognition (FEEST) as a continuous variable and general cognition (MoCA) (r=.566, P<.001). The relationship between MoCA and FEEST has been further investigated by means of a crosstab in which FEEST and MoCA (<26) both were divided by impaired vs not impaired. Among patients with normal general cognition (MoCA ≥26), 10.9% had impaired visual emotion recognition. In addition, 61.4% had an impaired MoCA with a normal score on the FEEST (table 3).

Discussion

This study shows that impaired visual emotion recognition is relatively common in mildly affected stroke patients in the subacute phase. We found a prevalence of 25%. In addition, we found that impaired general cognition is correlated with impaired visual emotion recognition. We found a linear relationship between MoCA and FEEST scores with a moderate correlation. These results could indicate a relationship between impaired visual emotion recognition

Table 1 Prevalence of impaired visual emotion recognition and general cognition.

	MoCA Impaired	MoCA Not Impaired	Total FEEST
FEEST impaired	22 (19.6)	6 (5.4)	28 (25)
FEEST not impaired	35 (31.3)	49 (43.7)	84 (75)
Total MoCA	57 (50.9)	55 (49.1)	112 (100)

Data are presented as n (%). MoCA impaired <26. MoCA not impaired ≥26. FEEST impaired ≤ the fifth percentile. FEEST not impaired > the fifth percentile.

and general cognitive problems. On the other hand, further analysis also showed that 11% of patients with normal MoCA scores had an impaired FEEST. Mood was negatively related with FEEST, and thus patients with an impaired FEEST, have a significantly better mood. The last main finding is the lack of association with sex, site, and localization as possible determinants.

Other studies also found disturbances in visual emotion recognition in patients with mild stroke. Nijsse et al found significantly lower emotion recognition scores[22] (mean, 42.63) in stroke patients (81.7% had a mild stroke), compared with controls with no stroke. As far as we know, there is only 1 other prevalence study,[23] in which the prevalence was 33.5%. This higher percentage can be explained by the difference in stroke patients. We specifically selected patients with a minor stroke, as a lower prevalence in milder stroke is likely.

Another important point is the correlation between visual emotion recognition and general cognition. Evidence for this relationship was also shown in a study between facial affect recognition deficits and nonverbal memory, working memory, speed of processing, verbal delayed memory, and verbal learning deficits in patients with traumatic brain injury.[33] This is in line with another study in which a curvilinear association between cognitive function and recognition of emotions in facial expressions was founded in older adults.[34] The question arises of whether, given the moderate correlation of FEEST with MoCA, FEEST actually measures emotion recognition and possibly other cognitive functions. In other studies, a weak association was found between FEEST and requiring complex visual perception and a naming test.[22] Aben et al also found weak but significant correlations between FEEST and processing speed, executive function, and memory.[23] The moderate correlation we found can be explained by the use of another instrument. The MoCA is a screener used to investigate different domains and provides a "composite score." For example two persons with the same score on the MoCA can have problems in very different domains. If the cognitive domains included in the MoCA were all examined separately, one would find many different profiles, and there would be less correlation with emotion recognition. Another result in the study of Aben et al contradicts this; they found impairment in emotion recognition in 20% of stroke patients with normal general cognition.[23] Our result is in line with these results. In our study, we found that 10.9 % of patients with impaired emotion recognition had normal general cognition scores, whereas 61.4% of patients with impaired cognition performed normal on emotion recognition. This provides evidence for the presence of double dissociation; emotion recognition is a cognitive function that can be impaired without affecting other functions and vice versa. Visual emotion recognition appears to be independent of general cognition. The negative association between FEEST and mood was intriguing. Impaired FEEST goes along with a significantly better

Table 2 Patient characteristics, comparing between patients with impaired and with normal visual emotion recognition.

Characteristics	Impaired FEEST, n (%)	Normal FEEST, n (%)	Test Statistic (*df*)	*P* Value
Demographics				
N	28	84		
Age (y), mean (SD)	70.1 (9.3)	71.1 (11)	$t(110)=0.36$	.646
Sex			$\chi^2(1)=2.48$	.176
Male	21 (30)	49 (70)		
Female	7 (17)	35 (83)		
Education			$\chi^2(1)=0.06$	.800
Low	21 (24)	65 (76)		
High	7 (27)	19 (73)		
Stroke characteristics				
mRS, median (SD)	0 (0.7)	1 (0.6)	$\chi^2(2)=2.79$	.247
NIHSS, median (SD)	0.5 (1)	0 (0.8)	$\chi^2(3)=5.96$	.113
Laterality			$\chi^2(2)=0.86$	.648
Left hemisphere	9 (20)	35 (80)		
Right hemisphere	11 (27)	30 (73)		
Other	8 (30)	19 (70)		
Localization			$\chi^2(3)=1.25$	.739
Cortical	11 (27)	30 (73)		
Subcortical	10 (25)	30 (75)		
Lacunar	7 (23)	23 (77)		
Posterior circulation	0 (0)	3 (100)		
MoCA, mean (SD)	23.0 (3.3)	25.1 (3.3)	$t(110)=2.78$	.006
PHQ-4, median (SD)	1 (1.4)	2 (2.2)	$U=884$	.046

NOTE. Impaired FEEST was defined as ≤5 percentile score. Education: low, 1-5; high, 6-7 (Verhage, 1964).[35] Stroke characteristics were defined by severity (mRS range, 0-6; NIHSS range, 0-42), laterality (defined by which hemisphere was affected by stroke: left, right, or other [cerebellum, brainstem]), localization (cause/localization of the stroke), general cognition (MoCA range, 0-30), and mood (PHQ-4).

Table 3 Patient characteristics for patients with normal and impaired general cognition and visual emotion recognition

	MoCA Impaired	MoCA Not Impaired
FEEST impaired	22 (38.6)	6 (10.9)
FEEST not impaired	35 (61.4)	49 (89.1)
	57 (100)	55 (100)

NOTE. Data are presented as n (%). MoCA impaired <26. MoCA not impaired ≥26. FEEST impaired ≤ the fifth percentile. FEEST not impaired > the fifth percentile.

mood. Our hypothesis for this finding is that this relationship can possibly be explained by impaired awareness of illness. This is consistent with our experience in clinical practice. This also means that a follow-up study investigating how partners and caregivers experience these problems is important.

Regarding the lack of association with sex, site, and localization, the lack of a relation with localization is especially remarkable. Many studies focused on the role of hemispheric lateralization in emotion recognition. One review[36] demonstrated a right hemisphere dominance for emotional perception. A study by Tippett et al, for instance, showed that right hemisphere stroke patients were significantly less accurate in identifying all positive and negative emotional facial expressions and neutral expressions. Patients with right amygdala lesions in particular had significantly lower scores on recognition of happiness and anger.[37] Also, Nijsse et al found no differences between right and left hemisphere stroke patients with regard to different domains of social cognition.[22] A possible explanation of Nijsse et al[22] is that minor strokes are often lacunar infarctions involving small penetrating arteries in the deep areas of the brain, not located in cortical areas that are often related to problems in social cognition. However, our results do not appear to point in that direction, and almost 75% of the infarctions did not concern lacunar infarctions. Moreover, we found no significant difference between the different locations (table 2). We propose that that the process of visual emotion recognition has multiple stages and that multiple neural networks are involved.[11] Visual emotion recognition is not limited to the right hemisphere or to major strokes. A strength of the present study is that we only examined patients with minor stroke.

Study limitations

Our study has some limitations. First there is the lack of a control group; however, we have used reliable standards for the FEEST. Furthermore, we used the FEEST as a categorical variable rather than a continuous variable. By using the categorical variable we were able to determine a prevalence. The disadvantage of using a categorical variable instead of the continuous variable is that reality is more nuanced. For example, patients inthe 8th percentile may also have problems recognizing visual emotions. Finally, we examined our patients in the subacute phase, with a short follow-up period of 6 weeks postonset. It is unknown whether patients with a minor stroke continue having problems with visual recognition of emotions on the long term. This is currently being investigated in our research group.

Conclusions

Patients with a mild stroke are at risk for problems with visual emotion recognition. General cognitive problems are a possible determinant. Impaired visual emotion recognition can have important consequences for daily life. We mainly suggest early detection, for example by screening for impaired cognition and asking questions about changes in behavior and relationships, especially in patients who are discharged home and do not receive rehabilitation. Mild stroke is unfortunately not equal to mild consequences.

Supplier

a. SPSS, version 25.0; IBM Corp.

Keywords

Facial emotion recognition; Prevalence; Rehabilitation; Stroke

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