Recognition of emotions by voice and facial expression by medical students

Reconhecimento de emoções pela voz e expressão facial por estudantes de medicina

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ABSTRACT

Purpose: To evaluate the ability of medical students to recognize emotions through voice and facial expression through assessments of emotional perception of vocal intonation and functional expressions. **Methods:** Observational cross-sectional study. To evaluate the recognition of emotions by facial expressions, a test composed of 20 videos of facial microexpressions was used, and to evaluate the emotional recognition by voice, the protocol of prosodic impressions of basic emotions, based on the Burkhardt database, was used. For statistical analysis, the Friedman, Shapiro-Wilk, Student t, Mann-Whitney and Pearson or Spearman correlation coefficient tests were used. **Results:** The study consisted of 38 students, with an average age of 20.8 (±2.5). The recognition of emotions through the voice was significantly superior to the one through facial expressions. There was a positive correlation between age and the ability to recognize emotions through facial expressions. Males had a significantly higher hit rate than females in the ability to recognize emotions through facial expression. The emotions with the highest average success rates through facial expression were surprise, joy and contempt, while, through the voice, the emotions were anger, fear and sadness. **Conclusion:** The ability to recognize emotions by medical students was greater when assessing emotional perception through the voice.

Keywords: Emotions; Voice recognition; Facial recognition; Nonverbal communication; Empathy; Health communication

RESUMO

Objetivo: avaliar a capacidade de estudantes de medicina para reconhecer emoções pela voz e expressão facial, por meio de avaliações de percepção emocional da entonação vocal e das expressões faciais. **Métodos:** estudo com delineamento transversal observacional. Para avaliação do reconhecimento de emoções pelas expressões faciais, utilizou-se um teste composto por 20 vídeos de microexpressões faciais e, para avaliação do reconhecimento emocional pela voz, utilizou-se o Protocolo de Reconhecimento de Emoções Prosódicas Básicas, baseado no banco de dados de Burkhardt. Para análise estatística, foram utilizados os testes de Friedman, Shapiro-Wilk, teste t de Student ou Mann-Whitney e o coeficiente de correlação de Pearson ou Spearman. **Resultados:** o estudo foi composto por 38 alunos, com média de idade de 20,8 (±2,5). O reconhecimento de emoções pela voz foi significativamente superior, comparado com os resultados do teste de reconhecimento de emoções pelas expressões faciais. Houve correlação positiva entre a idade e a habilidade de reconhecer emoções pelas expressões faciais. O gênero masculino apresentou taxa significativa de acertos, superior ao gênero feminino na habilidade de reconhecer emoções pela expressão facial. As emoções com maior média de acertos pela expressão facial foram surpresa, alegria e desprezo, enquanto, por meio da voz, as emoções foram raiva, medo e tristeza. **Conclusão:** a capacidade de reconhecimento de emoções por estudantes de medicina foi maior na avaliação de percepção emocional por meio da voz.

Palavras-chave: Emoções; Reconhecimento de voz; Reconhecimento facial; Comunicação não verbal; Empatia; Comunicação em saúde

INTRODUCTION

During the practice of their profession, physicians need to overcome challenges of a technical nature, which involve the knowledge acquired during their academic training. This may cover different pathologies and their anatomical and physiological correlations. At the same time, this subject is characterized as a healthcare professional who, like all others, is exposed to patients with different sociocultural and personal characteristics, requiring good communication and appropriate relationships from the clinician for each specific situation[1].

In medical practice, effective communication allows the establishment of a bond and obtaining the patient's trust, an aspect that contributes to the success of the treatment[2]. It is noteworthy that, to be successful in interactions and bonding with patients, communication is an essential factor, and it is important to observe the appropriate use of words and how one speaks, characterizing the verbal part of communication, which represents the entire portion of verbalized communication.

On the other hand, it is important to be aware of non-verbal communication, which can be understood as the non-verbalized aspects present in an interaction, and which represent communicative value in the composition of the message transmitted, consisting of gestures, facial expressions, vocal intonation and body movements[3]. It is essential that all health professionals, particularly physicians, know non-verbal communication fundamentals so that this skill contributes to greater satisfaction in clinical care[4].

Facial expressions and vocal intonation can be cited as important pillars of non-verbal communication. These factors are closely linked to the human capacity to express their emotions in a genuine way[5]. Although there is no consensus in the literature, there are six basic emotions widely described: joy, fear, surprise, sadness, disgust, and anger[5]. With regard to emotional expression through non-verbal communication, changes in the individual's emotional state can cause variations in the rhythm, tone, and speed of the voice. This occurs in addition to the use of muscles and components of the face, with involuntary changes in facial features.

There is evidence that people capable of recognizing emotions in others during an interaction demonstrate more assertiveness when communicating, adapting the use of language to the context of their conversational partner[6], with the recognition of emotions being an important skill for generating empathy and for establishing bonds[7].

In this scenario, recognizing emotions becomes important within medical practice and during the period of their training, in which they are already oriented to deal with situations involving care. This skill can help in an assertive interaction that promotes a genuine connection with the individual[6]. A professional's effective communication allows them to adapt their language to convey security and empathy when welcoming the patient, leading to the successful formation of a bond for the session and/or therapeutic process: the patient's health[8].

Therefore, the present study aimed to evaluate the ability of medical students to recognize emotions through voice and facial expression, through assessments of emotional perception of vocal intonation and facial expressions.

METHODS

This is a cross-sectional observational study, linked to the randomized clinical trial called "Neurobiological modulation and empathy in improving health communication skills", from the Graduate Program in Rehabilitation Sciences at the Federal University of Health Sciences of Porto Alegre (PPG-CR/UFCSPA), approved by the Research Ethics Committee, under consideration 5.204.872.

Medical students, of both genders, aged between 18 and 30 years old, regularly enrolled between the first and second year of the course at a federal university in southern Brazil, were invited to participate in the study. In the first stage of the process, students who agreed to participate in the study signed the Free and Informed Consent Form (FICF), after explaining the progress of the project, and responded to the questionnaire to characterize the sample (Appendix 1).

Afterward, the group was subjected to a test based on studies[9] on emotions and facial expressions (Annex 1). The test consists of the presentation of 20 videos taken from the E-Facials[10] platform, designed to test individuals' ability to recognize emotions through facial microexpressions. In these videos, actors receive a visual and auditory stimulus and, genuinely, present a reaction in the form of a facial microexpression, which characterizes one of seven emotions: joy, fear, anger, surprise, disgust, contempt, or sadness. Each of these emotions was presented at two or three different moments randomly, and each of the videos was shown twice at the time of evaluation. The students were instructed to select one of the seven emotions that they considered most appropriate, according to the facial expression presented in the video. All videos were presented in person, using image projectors in the university classrooms, without audio, and the application was conducted in groups.

To conclude, the students responded to the Basic Prosodic Emotion Recognition Protocol, based on Burkhardt's database[11] (Annex 2), a free tool widely used in research on emotion recognition through voice. The justification for choosing this instrument was because, at the time of carrying out this study, there was no similar tool validated in Brazilian Portuguese. The application of this test consisted of the use of 21 audio files, with a phrase in German - In sieben Stunden wird es soweit sein - which translates as "This will happen in seven hours". This phrase was presented in different intonations performed by trained actors, in order to characterize one of the following emotions: joy, fear, anger, sadness, boredom, disgust, or neutrality. Students were instructed to rely solely on vocal prosody to answer the test. Each of the audios was played twice, consecutively, and each of the emotions was randomly presented at three different moments. The instruction given to the students was for them to mark an emotion that they considered most appropriate for each of the items, using only intonation and/or vocal prosody as a reference. The audios that made up the test were presented in a group, in person, through speakers connected to the computer in the room, at an appropriate volume intensity for all participants.

For each audio or video presented, there was a single correct answer, according to the authors of each test, that is, a specific emotion. In this way, by comparing the emotion indicated by the individual with the correct answer to each item, it was possible to verify the effectiveness of the sample in recognizing each of the emotions. In addition, it was also possible to compare the

possible differences in the recognition of these emotions when presented by facial expression and voice.

The sample calculation was oriented toward the average accuracy, based on the material composed of 20 videos and 21 audio files, and each student obtained a percentage of correct answers in recognizing emotions, representing their accuracy. Each participant had an accuracy of correct answers in the audio samples, and videos, individually for each emotion, for each of the tests, and an overall accuracy, which considers the total percentage of correct answers in the tests. The sample was estimated at 31 students, considering a standard deviation of 14.8% for accuracy in non-verbal recognition (average = 85.6%)[12]. A margin of error of 5.5 was adopted for the 95% confidence interval.

The results of qualitative variables were presented using absolute and relative frequencies and quantitative variables as mean and standard deviation, when symmetrical, and median and interquartile range (IQR), when asymmetrical. Normality was verified by the Shapiro-Wilk test. The Friedman test with Bonferroni post-hoc was applied to compare the percentage of each emotion, depending on the means of recognition. To compare accuracy according to gender, Student's t-test or Mann-Whitney test was applied, and for comparison according to the type of emotion recognition, the t-test for paired data or the Wilcoxon test was applied. The Pearson or Spearman correlation coefficient was used to verify the correlation of accuracy according to the type of emotion recognition and age. The significance level adopted was 0.05. Analyses were performed using SPSS statistical software (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

RESULTS

The sample consisted of 38 students, 24 male (63.2%) and 14 female (36.8%). Regarding the race of the sample, 35 students identified themselves as white (92.1%), 2 students identified themselves as black (5.3%), and 1 student called themselves mixed race (2.6%). The age of the individuals varied between 18 and 28 years old, with an average of 20.8 (±2.5). Of this total, 36 students were in the first year of the course (94.7%), and only 2 students were in the second year (5.3%).

Each of the emotions tested presented a total percentage of correct answers for each of the tests, voice recognition, and facial expression. There was a significant difference in the percentage of correct answers depending on the type of emotion and the means of recognition, making it possible to perceive different performances for the same emotion when tested in different ways. All emotions tested by facial expressions had a percentage of correct answers equal to or less than 50%, while all emotions tested by voice had rates above 50%. (Table 1).

To compare the two means of recognition, voice, and facial expression, the calculation was carried out using the general performance of the students in each of the tests, considering, respectively, the percentage of correct answers in all videos and all audio samples. The general performance in recognizing emotions was higher through voice, compared to recognition through facial expressions, in a statistically significant manner (p<0.001), with a percentage of 78.4% of total correct answers for voice and only 31.8% for facial expressions. (Table 2).

The Spearman correlation test indicated a weak positive correlation between age and the ability to recognize emotions through facial expressions (rho = 0.358; p-value = 0.030).

Comparing the genders, a significant difference was found in the ability to recognize emotions through the voice, with male individuals standing out and presenting a higher average percentage of correct answers. No statistically significant difference was found concerning recognition through facial expressions (Table 3).

DISCUSSION

The ability to recognize emotions predisposes more effective communication in the health area, favoring the formation of a bond with the patient and contributing to the development of feelings of empathy and compassion. This is identified as beneficial, as they are related to positive outcomes in health treatments[13]. Added to this is the fact that, in a general context, medical students must be able to identify emotions, because this

Table 1. Comparison of the percentage of correct answers according to emotion and means of recognition

	Mean	SD	Median	p-value
Facial expressions (% correct)				<0.001
Surprise	50	27.7	50	
Joy	38.6	22.6	33.3	
Contempt	32.9	29.1	50	
Anger	34.2	22.6	33.3	
Sadness	28.9	24.7	33.3	
Disgust	23.7	17.2	33.3	
Fear	14.9	20.1	0	
Voice (% Correct)				<0.001
Anger	88.6	23.6	100	
Fear	88.6	20.9	100	
Sadness	85.1	25.3	100	
Joy	79.8	23.9	83.3	
Neutral	75.4	29.7	83.3	
Boredom	74.6	30.4	83.3	
Disgust	57	34.6	66.7	

Friedman test with post-hoc Bonferroni

Subtitle: % = Percentage; SD = Standard deviation

Table 2. Comparison of the percentage of total correct answers between facial expressions and voice

	Mean	SD	Median	p-value
Total - % correct answers for facial expressions	31.8	10.1	30	<0.001*
Total - % correct answers by voice	78.4	17	83.3	

* Statistically significant difference - Wilcoxon test
Subtitle: % = percentage; SD = Standard deviation

Table 3. Comparison of the percentage of correct answers between males and females for facial expressions and voice

		Mean	SD	Median	p-value
Total - % correct answers for facial expressions					
	M	30.4	9	30	0.345
	F	34.3	11.7	32.5	
Total - % correct answers by voice					
	M	81.5	18.3	85.7	0.027*
	F	73.1	13.5	73.8	

* Statistically significant difference - Mann-Whitney Test
Subtitle: % = Percentage; M = Male gender; F = Female gender; SD = Standard deviation

ability will represent the possibility of more assertive language in clinical practice[6].

Emotions can be understood as a set of physiological and psychological reactions and processes in the face of a situation[5]. In the literature, the existence of six basic emotions is described: joy, fear, surprise, disgust, anger, and sadness, with universal vocal and facial expression patterns, expressed naturally and unconsciously, which can be perceived during the presence of each one of these emotions[5].

From the comparison between the percentage of correct answers in the recognition of emotions, it is clear that the order of performance varies according to the stimulus, as its evaluation is subjective and composed of a series of contextual, vocal, and muscular patterns, called cues[14]. In a dialogue context, expression occurs through the set of one or more cues. However, by isolating auditory and visual cues and testing them separately, some emotions can be more easily identified through certain types of stimuli. In addition to this, it is noteworthy that each emotion expressed through non-verbal aspects transmits a message to whoever interprets it. Whether through what it transmits or through the vocal or muscular configuration characteristic of that emotion, each emotional expression can impact the individual differently, depending on the way it is presented.

A Brazilian study carried out in São Paulo sought to investigate the relationship between the ability of medical students to recognize emotions and empathy based on facial expressions presented through black and white photographs. They obtained a better response in the emotions of surprise and joy and worse judgment in the emotion of fear[15], confirming the findings of this study. Another Brazilian study also found fear to be the emotion with the lowest recognition rate[16].

The muscular activations present in the characteristic facial expression of surprise are the raising of the eyebrows, the wrinkling of the forehead, and the act of widening the eyes[17], being a facial expression similar to those present during the emotion of fear[17]. Thus, given the similarity between both facial expressions, there may be a proportional relationship in which, upon better recognizing surprise, this emotion begins to be confused with fear, thus causing a low rate of recognition of the facial expression of fear.

The emotions of anger, fear, sadness, and joy were the best evaluated in the voice recognition test, reaching more than 75% of correct answers, with the emotion of disgust appearing as the lowest score, close to 55%. Research carried out in Australia tested the ability of elderly people to recognize emotions at different intensities, through different channels of emotion transmission. The results found for emotions expressed through the use of voice brought similar scores, agreeing with the findings of this study for emotions of anger, joy, sadness, and disgust[18].

Burkhardt's database[11] was chosen to test the recognition of emotions through voice, due to the lack of a tool validated in Brazilian Portuguese. However, it is unlikely that the fact that the phrases used were recorded in another language will have a major impact on the results. Despite there being evidence of certain sociocultural influences on the transmission and perception of emotions[19], the literature points out the emotional patterns as universal[5,9], making it possible to verify this ability in different contexts and cultures, through tools produced in different locations around the world.

It should also be added that the content of the sentences is not important for the expression of emotion, a fact explained to the students before applying the test.

Both fear and anger are emotions associated with the perception of danger, related to the instinct to protect or feel threatened[20]. The vocal expression of anger is characterized by high vocal intensity and frequency, while fear is characterized by high frequency and low intensity in the voice, with both having, as a similarity, the presence of accelerated speech[21].

Thus, common characteristics are observed between the two emotions with the highest rate of vocal recognition, anger, and fear, in their social and acoustic aspects, factors that may be linked to the similar performance of these emotions. Furthermore, regarding the emotional expression characteristic of the feeling of anger, it is related to the vocal pattern of rapid vocal attacks, also present in the emotion of joy[21].

Each emotion expressed by the voice has different variations in fundamental frequency (f0) and pitch[21]. These are factors associated with the notable difference in each emotion expressed and, possibly, related to the greater ease in recognizing certain emotions through the voice. Vocal expressions of feelings of anger and fear, emotions most recognized by the sample, are

associated with high levels of pitch and fundamental frequency, being more variable in anger than in fear[21].

Better recognition of anger may be also associated with its social function since anger is understood as a negative reaction, sometimes more aggressive[20,22]. It can be concluded that carrying out any action that arouses this emotion is acting in a way that violates what is tolerable by the other individual. Therefore, the act of recognizing this emotion, in particular, is necessary for living in society to perceive, or not, disapproval of actions during social interactions.

The emotions described in the literature as vocal expressions with greater variation in intensity obtained better recognition rates from the sample, whether this variation was negative, with lower tones, as occurred in the emotions of surprise and fear, or positive, with higher tones, as happened in the emotions of joy and anger, while the worst performance was in the emotion of fear, in which there was less variation in vocal intensity[21,23].

The low rate of success in recognizing emotions through facial expressions noticed in the comparison of the recognition of different emotions and in the direct comparison between the means of recognizing emotions, highlighted the great difficulty of the sample in the ability to perceive feelings through facial expressions, a factor which did not occur in other studies of this type[15,16,18,24]. It is noteworthy that the comparison of the general performance between the two means of recognition was carried out using two different instruments, which present representations of some different emotions. This condition is related to limitations in the tools available and developed for research in the area. These limitations made it impossible to use instruments that were more compatible with different types of emotional expression.

The greater difficulty in recognizing emotions through facial expression by the sample may be attributed to the fact that some different emotions have very similar muscle activations[5], an aspect that may confuse the individual tested. On the other hand, although there are similarities in emotional expression through the voice, it is composed of variations in tone, speech rhythm, prosody, pitch, and fundamental frequency[21], which can facilitate the differentiation of emotions, even when there is a similar characteristic.

It is worth highlighting the fact that the individuals were tested using facial microexpressions, and quick and short movements, starting from a neutral position. The ability to recognize this type of emotional expression that is so quick and subtle is not something commonly trained, existing factors that can hinder the recognition of emotions, such as a lack of focus on key points during the presentation. However, it is possible to improve this skill with specific work aimed at this objective[25].

According to similar studies, the peak of the ability to recognize emotions occurs when the individual is in the age group described as "young adults"[26,27]. Studies that used samples with a slightly higher average age obtained better results for recognizing emotions through facial expressions[16,18,24,26]. On the other hand, research carried out with a similar sample, composed of medical students, found results that were closer to, but still higher than those of the present study, possibly due to differences in the tests used and the average age, which was higher in the study used for comparison[15].

It is possible that the sample in this study, being quite young and having little social and professional experience, has not yet reached the peak of its ability to recognize facial expressions, since more compatible results are found when compared with similar samples. This factor may help explain the low-performance rate in the ability to recognize emotions through facial expressions.

Although there are studies that point to the decline in the ability to recognize emotions through facial expression as the individual ages[26,27], the positive correlation found between age and performance in this test, although weak, does not contradict the literature. Since the sample evaluated was composed of individuals between 18 and 28 years of age, it is understood that this finding may be related to greater socio-emotional experience, which guarantees a broader knowledge of the patterns of each emotion expressed by the face.

Likely, the superior performance of males in the voice emotion recognition test was due to the greater number of men making up the sample. The literature points in the opposite direction, indicating that women are more responsive concerning the identification of emotions through facial expressions[15,27,28] and through vocal prosody[26], a fact possibly linked to sociocultural aspects[28].

Empathy is a social skill that involves perceiving and understanding what another individual feels[29]. A Brazilian study pointed to a positive correlation between the ability to recognize emotions through facial expression and the levels of empathy presented by an individual[15]. A negative fact, considering the low performance of the sample in this skill, since empathy is understood as beneficial for the patient treatment process[13].

A study carried out in Sweden identified a positive impact of emotion recognition training using facial microexpressions and dynamic stimuli on students[25]. Added to the findings of this study is the understanding that emotional expression is made up of standardized cues[14]. From this, although the sample presented negative results concerning the ability to recognize emotions through facial expression, it is possible to project an improvement in this ability if subjected to training aimed at improving the perception of visual cues that express emotion and other skills related to emotional recognition.

In a general context, it is important that medical students be able to identify emotions, also visually through facial expressions. In the clinical setting, this ability will represent the possibility of more assertive language[6]. As medicine is a profession that places the individual in front of fragile patients and family members, who need humanized support, it is essential to learn to understand emotions and communicate appropriately[30].

Although the ability to recognize emotions through facial expressions was lower in the sample, it is possible to project an improvement in this ability through specific training[25]. In this way, the acquisition of the aforementioned skill can appear in medical practice as another tool in the process of forming a bond with the patient, helping to establish a good therapeutic relationship and better results in the treatment process.

CONCLUSION

The recognition of emotions expressed through the voice was superior, compared to the recognition of emotions through facial expressions, by medical students who were part of the sample, which may indicate a better perception of the ability to recognize emotions through the voice.

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Appendix 1. Sample characterization questionnaire

Q1 Full name:

_____

Q2 Gender: (M) (F) **Q3** Date of birth: _____/_____/____ **Q4** Age: _____

Q5 Marital status:_____ **Q6** Telephone:(___)_____-_____

Q7 Email:_____

Q8 Race: ( ) White ( ) Brown ( ) Black ( ) Indigenous ( ) Yellow

Q9 Undergraduate course _____

Q10 Semester:_____

Q11 Do you currently undergo therapeutic/drug treatment(s)? ( ) Yes No

Q11.1 If yes, what type of treatment(s):

_____

Key: Q = Question

Annex 1. Emotion recognition test through facial expressions

NAME:

DATE:

Throughout the test, facial microexpressions will be presented in video format. For each expression presented, you must mark the option in the answer grid column that you think corresponds to that emotion.

Example: for micro-expression 1, which will be presented at the beginning of the test, you must mark the corresponding answer in line of video 1, in the column corresponding to the emotion you deem appropriate.

NOTE: You must only mark one emotion for each video.

	Joy	Anger	Fear	Surprise	Disgust	Contempt	Sadness
Video 1							
Video 2							
Video 3							
Video 4							
Video 5							
Video 6							
Video 7							
Video 8							
Video 9							
Video 10							
Video 11							
Video 12							
Video 13							
Video 14							
Video 15							
Video 16							
Video 17							
Video 18							
Video 19							
Video 20							

Annex 2. Basic Prosodic Emotion Recognition Protocol (Burkhardt)

NAME:

DATE:

Throughout the test, sentences in German will be presented. For each phrase presented, you must select the option that you think corresponds to the emotion represented in the audio.

Example: for sentence 1, which will be presented at the beginning of the test, you must mark the corresponding answer in the line of sentence 1, in the column corresponding to the emotion you deem appropriate.

NOTE: You must mark only one emotion for each sentence.

	Neutral	Joy	Fear	Anger	Sadness	Boredom	Disgust
Audio 1							
Audio 2							
Audio 3							
Audio 4							
Audio 5							
Audio 6							
Audio 7							
Audio 8							
Audio 9							
Audio 10							
Audio 11							
Audio 12							
Audio 13							
Audio 14							
Audio 15							
Audio 16							
Audio 17							
Audio 18							
Audio 19							
Audio 20							
Audio 21							