

Recognition of facial expressions in men and women

Prepoznavanje emocija s ljudskih lica kod muškaraca i žena

Boris Gregorić¹, Lovorka Barbir¹, Ana Čelić¹, Vesna Ilakovac², Mira Hercigonja-Szekeres³,
Marina Perković Kovačević⁴, Maja Frencl⁴, Marija Heffer^{1*}

¹Laboratory of Neurobiology,
School of Medicine, Josip Juraj
Strossmayer University of Osijek, Osijek

²Department of Biophysics, Medical
Statistics and Medical Informatics,
School of Medicine, Josip Juraj
Strossmayer University of Osijek, Osijek

³Hrvatsko Zagorje Polytechnics, Krapina

⁴Psychiatry Clinic, Clinical Hospital Osijek,
Osijek

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*Corresponding author:

Prof. dr. sc. Marija Heffer
Department of Medical Biology,
School of Medicine
Josip Juraj Strossmayer University of Osijek
Josipa Huttlera 4, 31 000 Osijek
e-mail: mheffer@mefos.hr

<http://hrcak.srce.hr/medicina>

Abstract. Aim: Emotional facial expressions are cross-culturally readily recognized. Although each of the emotions could be expressed by body language, we are better tuned to facial expressions. We wanted to confirm our assumption that recognition of facial expressions of emotions is an innate ability of individual brain with gender specific pattern. **Methods:** This survey was based on 12 photos, with 11 basic and complex emotions and a neutral face expressed by professional male and female actors that were given to 259 participants (139 females/120 males) from late childhood to young adult age. We tested the recognition of facial expressions of the following emotions: happiness, sadness, fear, contempt, disgust, surprise, confusion, shame, worry, anxiety and anger. **Results:** Female participants were better than male participants in recognizing emotional expressions on male faces. Also, facial expressions on female faces were significantly better recognized than on male faces. Remarkable accuracy in detecting happiness and surprise was in contrast to low ability for detection of worry and anxiety. We found that elementary school students are less able to recognize most of the expressions. **Discussion:** The female accuracy might partially be connected to the gender difference of visual perception and the constant reinforcement loop consisting of recognition, perception and production of expressions. Developmental difference in recognition of emotional expressions on female and male faces is probably due to some cognitive processes accessible to training during development. **Conclusions:** Gender specific pattern in recognizing emotions detected in this study could explain some misconceptions and traditional roles genders played during the course of cultural evolution.

Key words: emotions; facial expression; sex differences

Sažetak. Cilj: Izražavanje emocija prepoznatljivo je u svim kulturama. Premda se svaka emocija može izraziti govorom tijela, više smo upućeni na izraze lica. Željeli smo provjeriti pretpostavku da je prepoznavanje emocija s ljudskih lica urođena sposobnost svakog mozga, sa spolno specifičnim obrascem. **Metode:** Istraživanje je temeljno na 12 fotografija, 11 fotografija osnovnih i kompleksnih emocije te fotografija lica bez emocija, koje su odglumili profesionalni glumac i glumica. Fotografije emocija su dane ispitanicima, bilo je ukupno 259 ispitanika (139 ženskih/120 muških) čija se dob kretala od kasnog djetinjstva do rane odrasle dobi. Ispitali smo prepoznavanje izraza lica za sljedeće emocije; sreća, tuga, strah, prkos, gnušanje, iznenađenje, zbunjenost, posramljenost, zabrinutost, uznemirenost, ljutnju te lice bez emocija. **Rezultati:** Žene bolje od muškaraca prepoznaju emocionalne izraze na muškim licima. Izrazi ženskih lica bolje se prepoznaju nego izrazi muških lica. Zapanjujuća preciznost u prepoznavanju sreće i iznenađenja u suprotnosti je s malom sposobnošću utvrđivanja zabrinutosti i uznemirenosti. Ustanovili smo da učenici osnovnih škola slabije prepoznaju emocionalne izraze. **Rasprava:** Bolje prepoznavanje emocija koje pokazuju žene moglo bi djelomično biti vezano uz spolne razliku u vizualnoj percepciji te stalnoj petlji prepoznavanja, percepcije i stvaranja izraza. Razvojne razlike u prepoznavanju emocionalnih izraza na ženskim i muškim licima vjerojatno je uzrokovano nekim kognitivnim procesom podložnom treningu tijekom razvoja. **Zaključak:** Spolno specifični obrazac prepoznavanja emocija utvrđen ovom studijom može objasniti neke predrasude i tradicionalne uloge spolova tijekom kulturne evolucije.

Cljučne riječi: emocije; izrazi lica; spolne razlike

INTRODUCTION

Struggling to prove the theory of 'the unity of mankind' against racial theories of his time, Charles Darwin claimed that expressions of emotions were universal to the entire human kind and not unique to humans¹. He was also the first scientist who attempted to use photographs of a human face in a survey questioning the innate ability of recognizing expressed emotion². While Darwin was trying to connect the expression of emotions in animals and humans with the evolutionary theory, Duchenne studied the voluntary and involuntary component of different facial expressions. Duchenne published an extensive anatomical study explaining innervations of facial muscles with the original finding that muscles like orbicularis oculi and levator palpebrae superioris have predominantly autonomous control³. Based on this finding, he offered a diagnostic method for distinguishing the pyramidal and extrapyramidal deficit; patients with pyramidal deficit of one hemisphere produce an asymmetrical voluntary smile on the opposite side of the face, but when it is an involuntary smile it is a symmetrical or 'Duchenne smile' that includes orbicularis oculi activity⁴.

After Duchenne and Darwin there was an amazing gap in scientific studies of facial expression of emotions. They were considered culture-specific and mostly an inaccurate source of data without any possibility for objective measurements. In the early seventies three scientists obtained strong evidence that a set of basic emotions, including happiness, fear, anger, disgust and sadness, was cross-culturally recognized and expressed in a similar way on the face^{5,6}. Even when a culture has no word for a certain emotion, like Tahitians, who do not have an expression for sadness^{7,8}, or even when an individual facial muscle is variably present in the musculature of the face⁹, like the risorius muscle in people of Melanesian ancestry¹⁰, facial expressions are still deeply rooted in the unconscious brain and available for expression and recognition⁸. The advancement in computer technology has made the development of the first objective facial measurement technique, the Facial Action Coding System (FACS)¹¹, possible and set forward an

avalanche of research in psychology, cognitive neuroscience, anthropology and medicine¹²⁻¹⁵.

Nowadays we know that recognition of emotional facial expressions is an innate characteristic of the brain which starts in the neonatal period¹⁶. It is influenced by emotional and cognitive development¹⁷. This has been proven in humans but also in animals^{18,19}. We still have conflicting data about gender specific differences in recognition of basic emotions and moods²⁰, finding no sex differences²¹ or difference in the entire set of

We established that females are better at recognizing facial expressions, confirming prior findings, but also that emotions are better recognised on female faces.

emotions²². Using a newly designed questionnaire constructed from photo images of emotional facial expressions, we have tested the recognition of basic emotions and moods in late childhood, adolescent and young adult population. We assumed, based on the previous study²², that female participants and university students would be more successful in recognizing facial expressions and wanted to see how our method would compare to others.

METHODS

A total of 259 students attending elementary school, high school and university from Osijek (Croatia) were included in the study. There were 71 (27.4%) elementary school students, 117 (45.2%) high school students and 71 (27.4%) university students. There were 120 (46.3%) male and 139 (53.7%) female students included in the study. They ranged in age from 13 to 26 years (median age 18 years, 95% CI for median from 18 to 18). The age range of the elementary school students was from 13 to 15 (median age 14 years), high school students from 17 to 18 (median age 18 years) and university students from 21 to 26 (median age 22 years). The female students were significantly older than male students (difference between medians 1; 95% CI for the difference 0 to 3, Mann-Whitney $p=0.010$).

All participants were asked to fill out an anonymous questionnaire in order to determine their

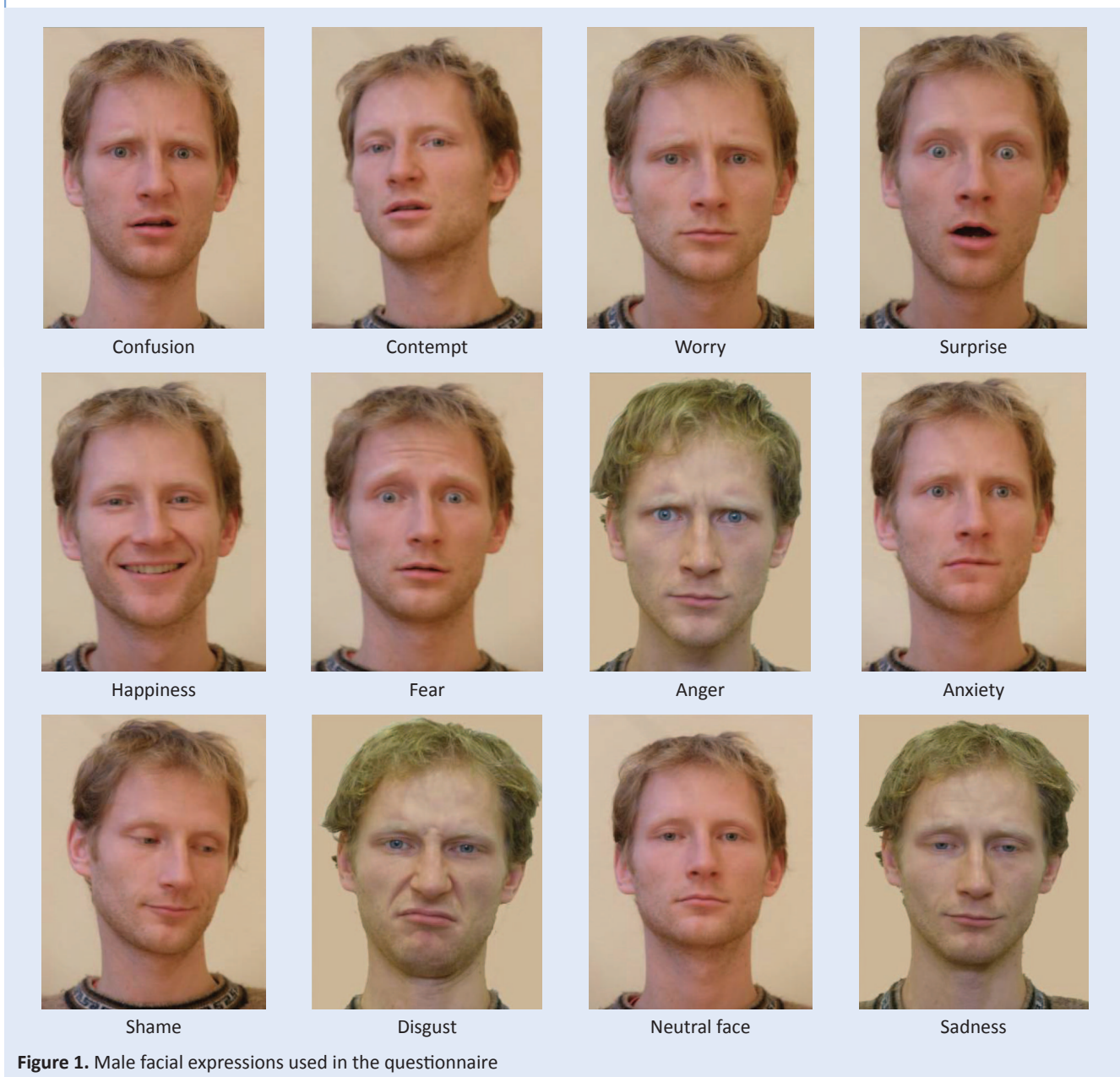


Figure 1. Male facial expressions used in the questionnaire

ability to recognize emotional facial expressions on male and female faces.

The questionnaire consisted of three parts. The first part included basic information about examinees. In the second part students were given 12 photographs of different facial expressions on a male face (Figure 1) representing a neutral face and 11 emotions: happiness, sadness, fear, contempt, disgust, surprise, confusion, shame, worry, anxiety and anger. In the third part students were given 12 photographs of facial expressions on a female face (Figure 2) representing a neutral face and the same 11 emotions, but in a different

order. The questionnaire was constructed from photo images of emotional facial expressions performed by a professional female and a professional male actor, each of photo image was modeled after descriptions published by Ekman and Friesen²³. This was the first study where we used these photo images of facial expressions. This way of depiction of emotions was not often used in other studies of facial expressions and makes our study unique. The students were asked to match each photograph with the corresponding emotion from the given list of randomly sorted 11 emotions and a neutral face. No definitions of



Figure 2. Female facial expressions used in the questionnaire

the emotions were given. Each correct answer was given one point.

The approval from the School of Medicine Osijek's Ethical Committee, written consent for students of full age and parental consent for under aged students were acquired prior to the study.

STATISTICAL METHODS

Categorical data was presented as absolute and relative frequencies. The proportion difference is calculated from the percentage of the correct recognition on female faces reduced by the per-

centage of recognition of the same emotion on male faces by the same subgroup or the whole group. Therefore, negative proportion difference means that an emotion on a female face was less recognized than on a male face. Difference in proportions was tested with exact McNemar's test. The scores were described by the median and 95% confidence intervals. The Wilcoxon signed rank test was used to compare emotion recognition scores within subgroups of students. The Kruskal-Wallis test and the Mann-Whitney test were used for the comparison of scores be-

tween subgroups of students. All p values were two tailed. The confidence intervals (CI) were estimated at the 95% level and calculated using the statistical package Confidence Interval Analysis (CIA) (version 2.0.0, Trevor Bryant, University of Southampton, UK). The analysis was conducted using the SAS software (version 8.2, Cary, NC, USA), with the significance level set at $p < 0.05$.

RESULTS

The median score in recognizing emotions on female faces was 9 (95% CI 8 to 9). The recognition of emotions on the male faces was significantly less successful (median score 8; 95% CI 8 to 9; difference of medians: 1; 95% CI for the difference 0 to 1; Wilcoxon's $p < 0.001$). The female students achieved better scores than the male students in recognizing emotions from the male (median 8 vs 8; median difference 1; 95% CI for the difference 0 to 1; Mann-Whitney test, $p = 0.030$) but not from the female faces (median 9 vs 8; median difference 0; 95% CI of the difference 0 to 1; Mann-Whitney test, $P = 0.143$).

The success in recognizing emotions on both male and female faces differed between schools (Kruskal-Wallis test, $P < 0.001$ for all). The elementary school students achieved the lowest median score in recognizing emotions on both male and female faces (Table 1).

Happiness was the most successfully recognized emotion on both (Table 2), female (100% correct answers) and male faces (99.6% correct answers). It was followed by surprise, which had a higher recognition on female (96.5% correct answers) than on male faces (90.3% correct answers). The two least successfully recognized emotions on both male and female faces were anxiety (18.9% and 15.4% correct answers respectively) and worry (21.6% and 17% correct answers respectively). The recognition of sadness had the largest difference between male and female faces. 77.6% of the participants recognized sadness correctly on female faces, while only 51% recognized it on male faces (difference 26.6, 95% CI from 19.4 to 33.5). This was also true when analyzed separately for female participants

Table 1. Median score in recognizing emotions by level of education

School	Median (95% CI) score in recognizing emotions	
	From women's faces*	From man's faces*
Elementary	8 (7-8)	6 (6-7)
High	9 (8-9)	8 (8-9)
University	9 (9-10)	9 (9-10)

* Kruskal-Wallis test, $P < 0.001$

Table 2. Success in recognizing emotions from facial expressions by type of emotion

Emotion	Number (%) of students who recognized emotion correctly		Proportion difference	95% CI		p*
	On women's faces	On men's faces		Lower	Upper	
Happiness	259 (100.0)	258 (99.6)	0.4	-1.1	2.2	-
Sadness	201 (77.6)	132 (51.0)	26.6	19.4	33.5	<0.001
Fear	164 (63.3)	149 (57.5)	5.8	-1.7	13.2	0.155
Contempt	181 (69.9)	164 (63.3)	6.6	-0.5	13.5	0.086
Disgust	239 (92.3)	224 (86.5)	5.8	0.9	10.8	0.028
Surprise	250 (96.5)	234 (90.3)	6.2	2.3	10.4	0.002
Confusion	142 (54.8)	162 (62.5)	-7.7	-15.7	0.4	0.077
Shame	210 (81.1)	190 (73.4)	7.7	1.8	13.7	0.015
Worry	44 (17.0)	56 (21.6)	-4.6	-11.4	2.2	0.219
Anxiety	40 (15.4)	49 (18.9)	-3.5	-9.6	2.7	0.321
Anger	215 (83.0)	198 (76.4)	6.6	0.5	12.6	0.043
Neutral face	250 (96.5)	224 (86.5)	10.0	5.7	14.8	<0.001

* Exact McNemar's Test

Table 3. Success in recognizing emotions from facial expressions by type of emotion in male participants

Emotion	Number (%) of students who recognized emotion correctly		Proportion difference	95% CI		p*
	On women's aces	On men's faces		Lower	Upper	
Happiness	120 (100.0)	119 (99.2)	0.8	-2.3	4.6	-
Sadness	93 (77.5)	57 (47.5)	30.0	19.8	39.2	<0.001
Fear	75 (62.5)	67 (55.8)	6.7	-4.9	18.0	0.322
Contempt	80 (66.7)	70 (58.3)	8.4	-2.3	18.7	0.164
Disgust	109 (90.8)	100 (83.3)	7.5	-0.5	15.7	0.093
Surprise	115 (95.8)	106 (88.3)	7.5	1.0	14.6	0.035
Confusion	62 (51.7)	67 (55.8)	-4.1	-16.1	7.9	0.59
Shame	92 (76.7)	75 (62.5)	14.2	4.6	23.4	0.006
Worry	20 (16.7)	25 (20.8)	-4.1	-14.3	6.1	0.522
Anxiety	17 (14.2)	27 (22.5)	-8.3	-18.3	1.7	0.143
Anger	99 (82.5)	87 (72.5)	10.0	0.7	19.2	0.050
Neutral face	114 (95.0)	100 (83.3)	11.7	4.5	19.4	0.003

* Exact McNemar's Test

Table 4. Success in recognizing emotions from facial expressions by type of emotion in female participants

Emotion	Number (%) of students who recognized emotion correctly		Proportion difference	95% CI		p*
	On women's aces	On men's faces		Lower	Upper	
Happiness	139 (100.0)	139 (100.0)	0.0	-2.7	2.7	-
Sadness	108 (77.7)	75 (54.0)	23.7	13.3	33.5	<0.001
Fear	89 (64.0)	82 (59.0)	5.0	-4.7	14.6	0.382
Contempt	101 (72.7)	94 (67.6)	5.1	-4.5	14.4	0.371
Disgust	130 (93.5)	124 (89.2)	4.3	-2.0	10.9	0.238
Surprise	135 (97.1)	128 (92.1)	5.0	0.1	10.7	0.065
Confusion	80 (57.6)	95 (68.3)	-10.7	-21.4	0.2	0.072
Shame	118 (84.9)	115 (82.7)	2.2	-5.4	9.7	0.701
Worry	24 (17.3)	31 (22.3)	-5.0	-14.1	4.1	0.349
Anxiety	23 (16.5)	22 (15.8)	0.7	-6.9	8.3	0.950
Anger	116 (83.5)	111 (79.9)	3.6	-4.4	11.6	0.473
Neutral face	136 (97.8)	124 (89.2)	8.6	3.0	15.0	0.004

* Exact McNemar's Test

(77.7% correct answers for female face versus 54% for male) and male participants (77.5% correct answers for female face versus 47.5% for male). The proportion of the participants who correctly recognized shame on the female faces was 7.7% higher (95% CI from 1.8 to 13.7%) than the proportion of the participants who correctly recognized shame on the male faces (Table 2). If we analyze the results obtained from male participants (Table 3) and female participants separately (Table 4), we can see the difference between the groups. Both male and female participants have recognized certain emotions better on the female face (sadness,

surprise, neutral face), however there are two emotions that male participants recognize significantly better on the female face. These are anger (82.5% correct answers on the female face versus 72.5% on the male face) and shame (76.7% correct answers on the female face versus 62.5% on the male).

DISCUSSION

The observation that women are better in decoding facial expression than men already existed in literature^{20,24}. One of the explanations might lay in developmental psychology; children recognize

emotions which they are also able to perceive and express themselves²⁵, starting from happiness, sadness and anger, and incorporating more complex ones in later development. Being more sensitive to other people's emotions could be gender specific and connected with being more susceptible to contagion by emotions of others, like it was stressed in the Dimberg and Lundqvist study²⁶. The female accuracy might partially be connected to the gender difference of visual perception and the constant reinforcement loop

Happiness and surprise were the most successfully recognized emotions by both genders whereas anxiety and worry were least successfully recognized.

consisting of recognition, perception and production of expression combined with a tendency to show emotions more frequently, what was proved especially for smiling^{27,28}. Also, it was found that women were more facially expressive than man on various emotional stimuli^{29,30} and had significantly thicker zygomaticus major muscle³¹, which is an explanation for better recognition of most of emotions expressed on a female face, although as we used only one male and one female actor this result could also be due to a better expression of the female actor. There was also a developmental difference in recognition of emotional expressions on female and male faces, the older participants being more successful, probably due to some cognitive processes accessible to training during development. It was previously established that high school students are more successful at facial expression recognition than elementary school students³² and our results show that university students are also more successful than elementary school students.

Both genders were most successful in recognizing happiness and surprise. Smile, especially the involuntary or 'Duchenne smile', is a frequent and a hard to fake signal, one of the first mutually exchanged between the baby and the mother and a good sign of honest intention in the evolutionary perspective^{13,33}. Contrary to smile, surprise is rarely met, but it is very characteristic and readily recognized (by open eyes and mouth).

Worry, anxiety and sadness are similar negative emotions, which were often confused by our participants. The expression of fear was also often confused with worry and vice versa Anger and contempt, two emotions that convey hostility, were also shown to be confused readily. It was previously found that emotions of anger and sadness were often confused²¹. We found this was not the case and that this happened rarely. This difference could be explained by the fact that the previous research included only four emotions, and anger and sadness were the only negative emotions in the study²¹.

CONCLUSIONS

Our study is an additional proof for gender specific differences in recognition of facial emotions. Some of the analyzed differences were previously known and expected, like better decoding of emotions by female participants, better recognition of all emotional cues from female faces, happiness as the most successfully recognized and worry and anxiety as the least successfully recognized emotions³². Some differences are already a matter of therapeutic intervention, like difficulty in recognizing negative emotions after traumatic brain injury^{34,35}, which seems to be a hard task in all social interactions. Despite the contemporary wish not to see the gender-specific difference, finding them and predicting their potential impact on modern society offers a good way to overcome misconceptions of traditional gender roles. We can count on much faster changes in social interactions due to a huge plasticity of the adult brain and its constant ability of rewiring which is reinforced by positive experience³⁶. For a next potential research we propose using a questionnaire with every emotion modeled by a different actor so that the individual expression capabilities of an actor would not interfere with the results.

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