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# Are Age and Sex Related to Emotion Recognition Ability in Children and Teenagers?

María Gallego-García[1], Germán Tenorio[1] and Susana P. Gaytán[2]

[1]Sevilla International College - San Francisco de Paula. Seville, Spain

[2]Physiology Department. Human Ethology Seminar. University of Seville, Spain

**Summary**

**Recognition of emotional facial expressions is considered a universal ability of human beings. However, despite the large body of literature on the subject, there are discrepancies in the results obtained by different authors about the influence of age and sex on the development of this ability. This inspired the following research question: Are age and sex related to the Emotional Facial Recognition (EFR) ability in children and teenagers? In this study, we investigated the recognition of three facial emotional expressions (i.e. happiness, anger, and sadness) in a population of Spanish children and teenagers. The study included 104 males and 106 females between the ages of 6 and 17 years. To assess the ability to recognize facial emotion, we used a questionnaire with images of different areas of the face (the eyes, the mouth, or the whole face) from models expressing a specific emotion. Our results suggest a subtle female advantage in emotional recognition as well as increasing emotional recognition ability with increasing age. These findings add to the extensive literature about the role of age and sex in EFR ability and suggest the importance of other factors, such as the types of emotion expressed or the areas of the face involved in the emotional expression, in the accuracy of the recognition.**

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## Introduction

*Homo sapiens* have a highly-developed sight sense, which allows us to perceive static details and different colours. This allows us to distinguish not only between the distinct facial expressions but also between the different faces of friends, family members, enemies and strangers (1). Accordingly, we possess the most developed facial musculature and the most complex facial expressions of the animal kingdom; these play a key role in the transmission of affective information, such as the different emotions (2). Therefore, faces are a valuable source of non-verbal information for the social interactions of daily life.

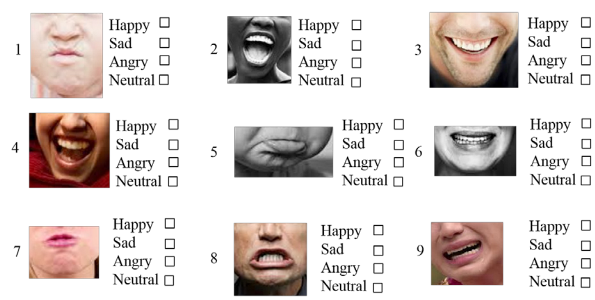


**Figure 1. Basic Emotions Surveyed in Questionnaire.** Images of different facial areas, here for example, showing images of the mouth. Participants were asked to check which basic emotion they felt the image represented.

Several studies provide evidence that sex and age influence one's ability to recognize emotional facial expressions (3,4). In early considerations of the possible relationship between age and emotional facial recognition (EFR), Darwin hypothesized that emotional expressions are inherited, not learned (5). Later investigations corroborated his theory; such as Ekman and Friesen, who argued that members of an isolated tribe in New Guinea recognized the emotional facial expressions showed in pictures of western models and that they could even recreate them themselves (6). Woodworth and Schlosberg found similar emotional facial expressions in blind children and in sighted children (7). Eibl-Eibesfeldt, the founder of the human ethology field, also agreed with Darwin's theory, stating that the pattern and movement of facial muscles responsible for the different emotional expressions are phylogenetic adaptations that have been selected throughout evolution due to their adaptive value (8). According to this author, the development of the connections between the nerve cells and the effector and receptor organs in which the movement patterns are based obeys the instructions carried by heritable genes.

On the other hand, although the vast majority of authors agree that facial expressions communicate specific basic emotions (**Figure 1**) universally, many authors claim that the interpretation of facial expressions may be influenced by experience and culture. Therefore, age and environment could play an important role in the interpretive process (9–11). However, emotion perception was found to be the most universal branch of emotional intelligence, while emotion understanding and regulation were found to be more culture-specific (12, 13).

Furthermore, the recognition and processing of emotional facial expressions involves several brain regions, such as the amygdala and the prefrontal cortices (14), which are developed throughout childhood and adolescence. The time-dependent development of critical brain regions implies that there is an influence of age in emotional facial recognition accuracy (15). This is the anatomical substrate under the social behavior and the ability to understand or feel what another subject is experiencing from within the other individual's frame of reference (16). Previous research has shown that children's emotion recognition improves with age and reaches adult levels by 11 years (4). Moreover, Widen (17) suggests that children initially classify emotions in broad categories. As they grow older, these categories become more complex and specific. Widen and Russell (18) supports this theory, providing evidence that emotional concepts may develop gradually.

According to the "Differentiation Model" developed by Widen and Russell, happiness, sadness, and anger are the first emotional categories to emerge, followed by fear, surprise, and disgust (19). Authors such as Gao and Maurer (20) and Mancini *et al.* (21) also found that sensitivity to happy faces showed little increase from five years of age to adulthood compared to the other emotions; five-year-olds had similar accuracy as adults in the recognition of these expressions. On the other hand, Thomas *et al.* (14) found that facial recognition of anger develops later than recognition of fear, which could be the result of the late maturation of the prefrontal cortex, an area that shows an increase in activity during the recognition of angry faces.

Regarding a possible relationship between sex and the ability to identify emotional facial expressions, scholars have argued that the capacity to build personal bonds and the social nature of facial emotional expressions have their origin in the mother-infant relationship created just after childbirth (8). This bond takes place through the visual contact between mother and baby and the smile that appears in the baby's face during rapid eye movement (REM) sleep (22). In addition, several studies (23, 24) have reported differences in regional activation of the brain between males and females during EFR, which may reflect different neural processing of emotional facial expressions. This could, perhaps, explain the superiority in females' ability to recognize emotional facial expressions suggested by numerous studies (25–28). However, other authors (29, 30) did not observe significant differences in EFR between sexes.

Based on these ongoing discussions and diverging results, we aimed to contribute to the field by verifying whether there are differences in the emotion recognition ability between sexes and ages. We conducted a questionairre presenting multiple images of faces expressing varying basic emotions (**Figure 2**). We tested whether females are better at identifying emotions from facial expressions than males, and if older observers are better at EFR than younger subjects.


**Figure 2. Image Presentations with Correct Recognized Emotion.** Set of pictures with human models representing partial and complete facial expressions of happiness, anger, and sadness used in this study. Each line shows an image trial and represents the order of picture presentation on each page of the questionnaire, with the corresponding answer.

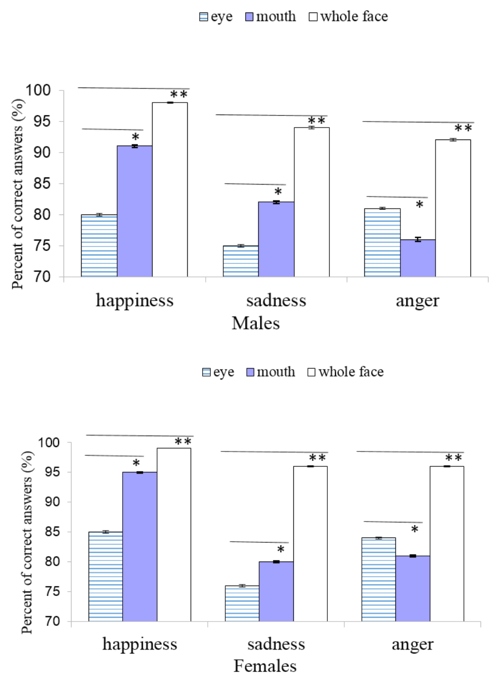


**Figure 3. EFR Ability (±SE) by Type of Emotion and Area of Expression.** In males ($N$=104) and females ($N$=106). Asterisk (*) indicates $p$<0.01, two asterisks (**) indicate $p$<0.0001. Similar patterns were found in both males and females, with no significant differences between them.

## Results

This study investigated Emotional Face Recognition – the recognition of happiness, anger, and sadness from facial expressions – in a population of Spanish children and teenagers. To assess the ability to recognize facial emotional expressions, we used a questionnaire with images of different areas of the face (the eyes, the mouth, or the whole face) from models expressing a specific emotion (**Figures 1 & 2**). The study included 104 males and 106 females between the ages of 6 and 17 years.

We found significant differences in the ability to recognize the different emotion categories considered in our study, irrespective of age, sex, and area of expression ($\chi^2(2, N=630) = 42.39$, $p<0.0001$). Recognition of happiness showed a greater percentage of correct answers ($M$ = 91.47%; $SD$ = 11.88) than recognition of sadness ($z$ = –6.40, $p$<0.0001) and anger ($z$ = –4.46, $p$<0.0001), but no significant difference was observed between the recognition of sadness ($M$ = 83.02%; $SD$ = 15.61) and anger ($M$ = 84.99%; $SD$ = 16.84). We also found significant differences in the facial recognition ability of the three tested emotions (happiness: $\chi^2(2, N=210) = 102.09$, $p$<0.0001; sadness: $\chi^2(2, N=210) = 87.46$, $p$<0.0001; anger: $\chi^2(2, N=210) = 58.49$, $p$<0.0001). All three emotions were better recognized from photographs of the whole face than from photographs of only the mouth or eyes ($p$<.0001). Anger was better recognized from eye expressions than from expressions in the mouth area ($z$ = –2.19, $p$=0.01). On the contrary, sadness and happiness were better recognized from expressions in mouth than from expressions in eyes ($p$=0.01). These patterns were found in both males and females (**Figure 3**).

Although females consistently achieved higher scores than males when looking at sex-related differences, irrespective of age and area of expression, no significant differences were found (happiness: $z$ = –1.88, $p$=0.060; sadness: $z$ = –0.20, $p$=0.845; anger: $z$ = –1.23, $p$=0.22). We also found no sex differences regarding overall results by area of expression. However, own-age analysis among sexes showed that females had significantly higher EFR scores than males within 6.5-years-old ($z$ = –2.247; $p$=0.025) and 14.5-years-old ($z$ = –2.786; $p$=0.005) groups.

Considering age-related differences in the EFR ability regardless of area of expression, we found significant differences in males ($\chi^2$ (5, $N$=104) = 26.13, $p$<0.0001) and females ($\chi^2$ (5, $N$=106) = 47.28, $p$<0.0001). Mann-Whitney U Test revealed that the scores achieved by 6.5-year-olds were lower than those achieved by the rest of the groups ($p$<0.0001). The overall trend was an increase in EFR ability with age (**Figure 4**), which was more pronounced in females ($r$ (104) = 0.598; $p$<0.0001) than in males ($r$ (102) = 0.248; $p$=0.011).

Regarding results by area of expression, irrespective of sex, the three tested emotions were better recognized by all age groups from expressions in the whole face

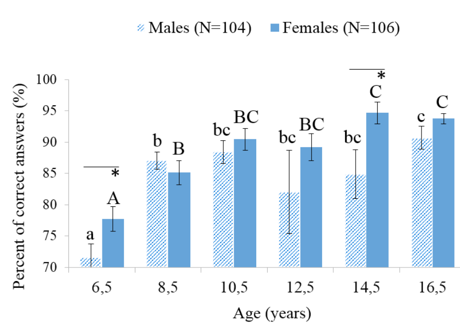


**Figure 4. Correct Answer Percentages (±SE) in EFR Ability by Age and Sex.** Lowercase and uppercase letters indicate post-hoc Mann-Whitney U test results for males and females, respectively. The same letter indicates no significant differences between sex-matched age groups. Asterisks indicate significant Mann-Whitney U test results between age-matched males and females (* $p$<0.05), ($N$ = total cases of males and females).

than from expressions in only mouth or eyes ($p$=0.05). EFR ability from expressions in eyes and mouth was significantly lower in 6.5-year-olds ($z$ = –2.80, $p$=0.005). We also found a positive age-related relation on EFR ability from emotional expressions in eyes and mouth ($r$ (208) = 0.40, $p$=0.01; $r$ (208) = 0.39, $p$=0.01, respectively); however, no age relation was found on EFR ability from emotional expressions in the whole face ($r$ (208) = 0.06, $p$=0.5).

After breaking down the results by the type of emotion considered, recognition of happiness from expressions in the mouth and in the whole face did not show significant age-related differences. However, recognition of happiness from expressions in the eyes was significantly lower in the group of the youngest participants (6.5-year-olds) ($p$<0.0001) and significantly higher in the group of the oldest fellows (16.5-year-olds) ($p$=0.02). Similarly, recognition of sadness from expressions in eyes was significantly lower in the group of 6.5-year-olds ($p$=0.01). Recognition of sadness from expressions in mouth and in whole face only showed significant differences between the youngest and the oldest participants ($z$ = –6.082, $p$<.0001). Recognition of anger from expressions in mouth showed no significant differences among 6.5-year-olds and 12.5-year-olds. Both displayed lower EFR ability than the rest of groups ($p$=0.01). However, only the recognition of anger from expressions in eyes displayed a clear positive relationship with age ($r$ (208) = 0.54, $p$<0.0001).

## Discussion

As indicated by previous research (3, 4, 34), the present results show differences in the ability to identify emotions in faces between different demographic groups. Our results suggest a slight female advantage at identifying emotional facial expressions compared to age-matched males, particularly among 6.5 and 14.5-year-olds. At younger ages, females displayed a greater ability to recognize facial expressions of emotions under conditions of partial stimulus information, *i.e.* when perceived emotion came from partial facial expressions. These results are consistent with McClure's who found a small but robust female advantage in facial expression recognition from infancy to adolescence when compared to age-matched males (37). Furthermore, the observed female advantage in EFR ability in the group of 14.5-year-olds agrees with Lawrence *et al.* (38) and is also consistent with Thompson and Voyer (28), whose study revealed that female's superiority in EFR takes place mainly between 13 and 30-year-old participants. This could be due to hormonal shifts that take place during puberty which, as Mancini *et al.* (21) suggest, could affect the EFR. Previous studies (39) suggest that hormonal fluctuations during the menstrual cycle affect the precision of a female's fear recognition. Additionally, testosterone receptors have been found in brain regions involved in EFR, such as the amygdala (40). Therefore, our observed difference in the increase of EFR ability with age between females and males could be due to sexually dimorphic hormonal development during puberty (41). In this line of thought, the change observed between the groups of 6.5 and 8.5-year-olds could be related to the release of adrenal androgens into the body that occurs during the first stage of puberty (42). Similarly, according to García Cuartero *et al*. (43), at 14.5 years, only females have reached sexual maturity (stage 5 in Tanner`s scale), conversely to the group of 16.5-year-olds, where both sexes have. This could explain the lack of significant differences between sexes in our oldest group.

On the other hand, observed females' advanced ability in facial emotion recognition among 6.5 and 14.5-year-olds could also be related to the human's sociability structure, which has developed from the capacity to establish personal bonds between mother and child, and thus guarantee the latter's protection and survival (8). Moreover, the main communication channel for babies is non-verbal. Therefore, it is essential that the mother knows how to recognize the different facial expressions of emotions, so that she can understand the infant's necessities.

Indeed, several studies (23, 24) found evidence of different emotional processing in females and males, as the process seems to take place in distinct brain regions for each gender. This could be explained through the sexual differentiation that takes place during prenatal development, which affects both external genitalia and brain development (44). Moreover, sexual hormones have a great impact on the brain, including modifying neural connections in such a way that females' and males' neural circuits are different (45).

With regards to age, the youngest age group showed the lowest ability for reading facial expressions. That could be related to the shift the child undergoes at 6 to 7 years of age. At this age, the child becomes more involved in his or her social relationships and pays more attention to others' emotions and expressions (46). This, coupled with the cognitive development and the maturing of the brain areas involved in EFR, could be responsible for the increase in recognition accuracy after age 6.5 years (4). Although in this study the youngest group showed the lowest ability in EFR, its percentage of correct answers was only 16% smaller than the oldest. This could be explained in part by the early acquisition of the emotional categories considered in this study (13, 14). For instance, two-year-olds are able to express all basic emotions (47), and five-year-olds are able to identify them (48), though only when they are expressed with a very high intensity.

This could be the reason that the 6.5-year-old group got more than 70% correct answers, as most images of the test had models intensely expressing the emotions. However, in the remaining images, the expressions were less clear or less intensely expressed, thus only the older and more experienced participants (16.5-year-old group) could recognize these emotions. Therefore, the percentage difference between both groups could reveal the increase in accuracy in EFR that takes place during puberty and adolescence. Moreover, in the youngest group, the differences in EFR in the distinct areas of expression were much greater than in the oldest one. This gradual improvement may be related to neural development, since at birth the human brain is only 23% of its final size. During the following six years, the brain undergoes a major growth; however, it is not until the individual turns 23 years old that the brain reaches its full development (49).

Our results suggest that improved accurate reading of facial emotional expressions with age also depends on the type of emotion. These findings are consistent with those reported by Herba *et al*. (50) who found that emotion category is an important component of emotion-processing. Although we found similar good performance within all age groups in the ability to accurately read each of the three emotions from expressions in the whole face, EFR from the eyes area or the mouth area gave rise to different patterns of results depending on age. While the performance of the oldest age group was the best, recognition ability of happiness expressions in the eye region was high throughout all age groups except for the youngest one. As the smile is a very distinctive feature of happiness, it is more easily recognized by the youngest group. This is supported by the similar results amongst all age groups in happiness recognition from expressions in the mouth and whole face, while differences in reading expressions in the eye area between the youngest and older groups were more noticeable. In contrast, we found increasingly accurate recognition of facial emotion with increasing age when reading anger from eye expressions. These results agree with Gao and Maurer's (21). Their study revealed that five-year-olds recognize happiness with ease, while the ability to recognize negative emotions, such as anger, from facial expressions does not mature until adolescence. Rodger *et al*. (51) found similar results, detecting an increase in sensitivity until adulthood to all emotional facial expressions except for happiness and fear. This could be explained by the late development of the ability to use configurational information when recognizing faces, which does not happen until ten years of age (6).

The differences we found in the ability to accurately recognize different emotions from facial expressions could be explained by the role of each of these emotions in social relationships. Threatening behaviors, such as anger, are necessary to establish and reinforce the social hierarchy, while happiness and sadness are affiliative behaviors, which promote group cohesion (27). Small children need support for survival, and thus, we hypothesize that the development of the ability to recognize cohesive emotions, such as happiness, prevails over recognizing negative and threatening emotions. Moreover, as they enter adolescence, kids' desire to be accepted by their peers increases, therefore increasing their sensitivity to signs of negative evaluation, such as angry faces (52).

Our research procedure had a few weaknesses that may have decreased the reliability of our results. Firstly, some of the images used were pixelated, making it more difficult for the participants to correctly recognize the emotion, particularly in the eye region. Moreover, when designing the test, the intensity of the emotional expression was not considered. There were differing numbers of images with high intensity expressions between the different emotions, resulting in uneven levels of difficulty in the identification of the distinct emotions, which affected the final results. Furthermore, since emotional photos were done by actors, it is possible that there were discrepancies between the actors' real emotions and the emotion they were faking/portraying In order to solve or minimize these sources of error in future studies, images from the Facial Action Coding System (FACS) database should be used, as the different emotions are classified by level of intensity, and they are great quality images.

Moreover, skin color, ethnic features, age, and sex of the models portrayed in the images used in the questionnaire were not controlled. Several studies (53, 54) suggest that accuracy in recognizing differences in faces increases when they are the same race as the observer. In addition, Verdichevski and Steeves (55) found an own-sex and own-age bias when recognizing faces; in other words, participants were more successful at correctly recognizing the identity of the models portrayed in the images when they were the same sex and age as the participant. Therefore, not taking into account these variables when selecting our facial presentation may have altered our results, thus, in order to solve this possible source of error, they should be controlled.

As an overall conclusion and answer to the research question, both sex and age seem to affect the ability to recognize facial expressions of emotions. Our results suggest that, in general, females are better at identifying facial emotional expressions than males, and that older children recognize expressions better than younger children. These observed differences in EFR ability with regards to sex or age seem to depend on the type of emotion, positive (happiness) or negative (anger), and the area involved in the emotional expression (whole face, eyes or mouth). Therefore, it would be interesting to carry out future studies in order to assess the relationship between both factors and EFR. To extend and improve the research, the age range of participants could be increased to include young children (4- to 5-year-olds), because major brain development and maturation occurs during these years (4).

Currently available evidence regarding EFR ability is mixed. Our results shed light on the influence of age and gender on this ability in children and adolescents, highlighting the importance of considering the different ages at which the main hormonal shifts take place during pubertal development, as well as the type of emotion expressed and the area of the face involved in the emotional expression when addressing this issue.

## Methods

### Participants

This study was carried out on 210 normal Caucasian students (106 females and 104 males) from the International school of Sevilla-San Francisco de Paula (Seville, Spain) aged between 6 and 17 years. The experiment took two weeks during which participants were recruited from each odd level of primary, secondary, and high school. Samples were grouped according to the enrollment level of the participants: G1 (*N*=32; 21 females, 11 males; average age of the level=6.5 ± 0.5 years old); G2 (*N*=43; 21 females, 22 males; average age of the level=8.5 ± 0.5 years old); G3 (*N*=31; 14 females, 17 males; average age of the level=10.5 ± 0.5 years old); G4 (*N*=26; 13 females, 13 males; average age of the level=12.5 ± 0.5 years old); G5 (*N*=31; 15 females, 16 males; average age of the level=14.5 ± 0.5 years old); G6 (*N*=47; 22 females, 25 males; average age of the level=16.5 ± 0.5 years old).According to the ethical rules for conducting behavior research with human beings (31), parental and guardian consent was requested so the minors could participate in our study.

### Stimuli

We focused our study on the recognition of happiness, anger, and sadness from eye, mouth, and whole face expressions. The mouth and eye regions are the main sources of expressive information of emotions in the face (32), but facial expressions of emotion should be most easily recognized in the whole face rather than in a part of it. Therefore, partial or complete facial expressions should imply different emotion recognition abilities since the area of the face shown to the participants may affect the accuracy of recognition (33). We narrowed our scope to the three early-emerging emotion categories according to Widen and Russel (18,19) because they were the easiest stimuli to find in real-life images.

### Design

Research design was based on Gaytán and Pásaro's protocol (34) with minor modifications, such as the duration of the test and the images used for facial emotion recognition. The task consisted of 27 image trials grouped into a three-page checklist questionnaire. Each page had three happy, three sad, and three angry facial expressions. One page showed only eyes, one showed only the mouth, and one showed whole faces (**Figure 1**). For each image trial, there was a checklist with four possible answers: happy, sad, angry, or neutral. The neutral option was included to enable replies even if no emotional meaning could be found in facial expressions. Each participant was asked to fill the questionnaire within ten minutes in grouped sessions by grade level.

### Image Selection

Following Ekman and Friesen's (35) criteria, a set of copyright-free pictures with human models showing facial expressions of happiness, anger, and sadness were selected from the internet. Skin color, ethnic characteristics, sex, age, or picture type of the face involved were not taken into account in the selection of the pictures. Partial (eyes or mouth) and complete (whole face) images of the selected pictures were used in the study (**Figure 2**).

### Procedure

After giving out the questionnaire to all the participants within each chosen school class we waited for them to write their sex and school grade. Afterwards, we briefly explained the study and how to fill in the questionnaire, specifying that there was a limited completion time (10 minutes) and that they could not go back to modify their initial answer. During the test, we answered participants' questions only if they related to the instructions. Once testing was completed questionnaires were collected.

### Data Analysis

A code was assigned to both the sex (male=1; female=2) and the area of expression (1=eye; 2=mouth; 3=whole face) variables. Since the age of participants was not available to us, we used the average age of their school level for age-related issues. The data was organized into a matrix of 210 rows (participants) and 27 columns (image trials).

As a measure of EFR ability, we used the relative frequency (%) of correct answers. EFR ability was sorted according to sex, age, and area of expression (eye, mouth, and whole face), for every type of emotion (happiness, anger, and sadness) without distinguishing between the types of stimuli. Blank answers (1.5% of all responses) were not taken into account. Because, according to the Kolmogorov-Smirnov test, the data did not meet the assumptions of normality and homogeneity of variances required for parametric tests, even with data transformation, we applied the non-parametric Kruskal-Wallis (multi-sample comparison) and Mann-Whitney U (two-sample comparison) tests to assess how much variance in EFR scores could be attributed to age, sex, type of emotion, and region (eyes/mouth/whole face). Pearson correlation coefficients ($r$) were calculated to test relationships between EFR ability (% of correct answers) and age. All analysis was conducted using SPSS v22 (36).

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