



Trajectory of the Recognition of Basic Emotions in the Neurodevelopment of Children and Its Evaluation Through the “Recognition of Basic Emotions in Childhood” Test (REBEC)

Victoria Poenitz¹ and Fabián Román^{2,3,4*}

¹ Fundación INARU, Concordia, Argentina, ² Department of Health Sciences, Universidad de la Costa, Barranquilla, Colombia, ³ Department of Psychology, Universidad de Maimonides, Buenos Aires, Argentina, ⁴ Red Iberoamericana de Neurociencia Cognitiva-Fundación Hippocampus, Buenos Aires, Argentina

OPEN ACCESS

Edited by:

Marcel Ruiz-Mejias,
Pompeu Fabra University, Spain

Reviewed by:

Eva M. Romera,
University of Cordoba, Spain
Anna Carballo-Marquez,
International University of
Catalonia, Spain

*Correspondence:

Fabián Roman
faromanmd@gmail.com

Specialty section:

This article was submitted to
Educational Psychology,
a section of the journal
Frontiers in Education

Received: 31 July 2019

Accepted: 08 June 2020

Published: 16 July 2020

Citation:

Poenitz V and Román F (2020)
Trajectory of the Recognition of Basic
Emotions in the Neurodevelopment of
Children and Its Evaluation Through
the “Recognition of Basic Emotions in
Childhood” Test (REBEC).
Front. Educ. 5:110.
doi: 10.3389/feduc.2020.00110

The neurodevelopment of emotion recognition is critical to achieving an adequate Social Cognition. This ability is developed during the first years through primary social referents, and later peers are a source of training that facilitates insertion in social groups. Most of the emotion recognition tests used are based on reagents that use adult faces, which can be a problem when evaluating the ability to recognize basic emotions in children. The objective of the research was to study this ability in children, analyzing its incremental validity on the variables age, valence, gender and emotional category. The Recognition of Basic Emotions in Childhood Test (REBEC) was designed using 30 reagents based on faces of children expressing five basic emotions of different intensity (low, medium and high). The REBEC was administered to 214 children, between 6 and 12 years old. The maximum score was 30. The average (M) of correct answers was 19.86; with a standard deviation (SD) of ± 4.12 . The study sample was divided into seven groups according to the level of schooling. The group of 12 years-old obtained the highest yield (M) 22.18 ± 4.12 . The 6-years olds' group obtained the lowest yield (M) of 17.78 ± 4.41 . The (M) of hits in girls was 20.61 ± 3.91 ; being of (M) 19.24 ± 4.21 for children. The Emotion Happiness was the most recognized (M) 93.8%, followed by Anger (M) 75.1%, Sadness (M) 58.6%, Disgust (M) 56.3%, and Fear (M) 47, 4%. We analyzed the level of success according to age, configuring the trajectory of Neurodevelopment for each emotion, taking incorrect categorization of emotions into account: disgust, tended to be confused with Anger or Sadness. After obtaining the normative data of the REBEC Test and observing its psychometric properties and the sensitivity for the detection of the differences between groups, it is postulated as a valid and reliable instrument for the measurement of the facial expression abilities of the basic emotions in childhood.

Keywords: emotions, recognition, test, social cognition (SC), learning, REBEC, neurodevelopment

INTRODUCTION

From a phylogenetic point of view, emotional expressions facilitate the adaptation of the human being to the environment. They are a strategy to communicate information that individuals need for effective interaction (Damasio, 1994). In 1999 Ralph Adolphs suggested that cognition depends on the neural mechanisms involved in the perception, recognition, and evaluation of certain types of stimuli and that these mechanisms are involved in the formation of complex representations of the social environment.

Recognizing an emotion implies knowing a list of components linked in a prototypical sequence, which includes typical causes, facial and vocal expressions, behavioral consequences, a label for the concept, among others (Widen, 2012).

In short, only when people can use facial expression of emotions as a channel of understanding and expression, will they properly interact with their environment. This environment, in turn, will lead to experiences that modulate this ability. It is, therefore, a self-regulation process that can be enabled through the implementation of intervention programs in emotional aspects (Gordillo et al., 2015).

As a subcomponent of social cognition, emotional recognition has traditionally been evaluated using skill tests in image labeling (reagents). However, it is possible to recognize certain limitations related to the ecological validity of the various standard instruments in psycho-pedagogical practice. Among them, some authors reported, for example, that children's performance in identifying emotions from photographs improves with age (Herba and Phillips, 2004; Golan et al., 2015; Gordillo et al., 2015). In this context, other authors suggest that the reliable interpretation of facial expressions seems to be a skill that develops with experience (Herba et al., 2006; Gao and Maurer, 2009). On the other hand, certain authors have stated that positive valence emotions are recognized earlier and with greater precision than negative valence emotions (Camras and Allison, 1985; Boyatzis et al., 1993; Widen and Russell, 2013, among others; Golan et al., 2015).

From the above follows that, in general, the instruments that have been used do not have the ability to measure the trajectory of the recognition curve of low, medium and high intensity facial expressions in all basic emotions. The possible technical relevance of the investigated subject's gender in relation to the gender of the reagent was not reported either. After reviewing the characteristics of previous developments, the hypothesis was that not all basic emotions, nor all their intensities, can be perceived universally; and that the performance in the capacity of that order is related to the development of the neurocognitive functions of the child.

The objective for the creation of the instrument was the construction of a reliable tool for the validation and psychometric analysis of the neurodevelopmental trajectory in the identification of facial expressions of joy, fear, sadness, anger and disgust, in third pairs and on three levels of intensity, in primary school children. In this way, the central objective was to measure the thresholds for each expression and the degree of equivocation between expressions, to contribute to

the previous findings by including intensity levels and all basic emotions.

The significant importance of its validation is conceived, contributing to the possibility of being used to establish correlations with other subcomponents of social cognition, as well as with other neurocognitive functions.

Finally, a better understanding of the evolution of the recognition of emotional expressions as an essential social function, will provide valuable normative data that could be reported for a subsequent identification of normo-typical emotional cognitive development patterns.

BACKGROUND

In recent decades, attempts have been made to scientifically elucidate how the brain processes emotions and, in particular, how this is done during childhood. Several authors discovered that in the course of neurocognitive development there are certain emotions whose recognition follows a slower pattern. This recognition improves significantly in late childhood. A certain current consensus on emotional recognition indicates that the ability to establish a connection between facial expressions and specific basic emotions appears around the age of two. Although preschoolers are able to recognize most basic emotions, their performance is far from perfect. The expressions of happiness and sadness are mostly recognized toward the age of five. However, the precision levels for expressions of fear and disgust, even beyond chance, are generally quite low at the age of five and will improve substantially over the next 5 years (Gosselin et al., 1995b; Gosselin and Larocque, 2000; Vicari et al., 2000; Gao and Maurer, 2009). The development patterns of anger recognition and surprise are to be considered as an additional point of debate, with different results in various studies.

Different works investigated the errors made in the classification of emotions and its non-uniformity. Bullock and Russell (1985), Gosselin et al. (1995a) reported that the confusion between "surprise" and "fear" is the most frequently made mistake by children between 5 and 10 years' old. There is also evidence of confusion in recognizing facial expressions to distinguish expressions of disgust and anger (Bullock and Russell, 1985; Camras and Allison, 1985; Gosselin et al., 1995a). Several researchers also discovered that one of the most common mistakes in recognizing expressions of surprise is the confusion with the expression of happiness (Bullock and Russell, 1985; Gosselin et al., 1995b). The magnitude of these errors decreases over time, but the errors persist even into adulthood (Gosselin et al., 1995a).

Facial expressions are clearly complex visual objects made up of various characteristics corresponding to different regions of the face. Some of these characteristics are easily detected, such as the opening of the mouth or the opening of the eyes. Others are more subtle, involving only slight muscle contractions or slight skin folds. The degree of differentiation between emotions is not homogeneous (Ekman, 2003) and this is a significant fact. Several authors agree that due to the complexity of facial expressions, visual discrimination of facial

expressions of emotions probably continues to improve during second childhood and is responsible, at least in part, for improved recognition (Gao and Maurer, 2009; Widen, 2012).

The contribution of several studies regarding this improvement in general performance for the recognition of emotions in relation to age, suggests that there are some elements of the visual system, whose maturation would only be reached at the end of childhood. The exact nature of this improvement remains to be determined. According to some research, the ability to discriminate between visual patterns improves well-beyond childhood and is related to various developmental changes, including physical maturation, increased attention span, more comprehensive visual examinations, and more efficient allocation of processing resources. What is conclusive is that the information processing involved in a labeling task represents a type of processing similar to the process that takes place in everyday life (Russell, 1994; Gao and Maurer, 2009; Widen, 2012).

Innatism vs. Developmentalism

In line with research related to innatism, some models propose that the neural structures, independent of experience, orient attention to certain aspects of the face, facilitating better recognition and learning (Morton and Johnson, 1991; Tarr and Gauthier, 2000). Tarr and Gauthier's work suggests that there could be two tasks that would require separable visual recognition systems in facial identification: determination to belong to a category (expensive object) and individualization (face of a particular person). The most notable version of this argument postulates the existence of a functional and neuro-anatomical division between the two mechanisms. From this point of view, there would be an innate form of a region of the visual cortex known as the "fusiform area of the face" ("FAF") specialized in facial recognition.

Along these lines, the theory of basic emotions suggests the assumption that children understand facial expressions in terms of specific discrete emotions. According to this theory, facial expressions have evolved to indicate specific emotions and to be universal, easy and innately recognized (Darwin, 1873; Ekman and Friesen, 1976; Ekman et al., 1987; Izard, 1994; Denham, 1998; Shariff and Tracy, 2011).

Authors who adhere to basic emotion theory suggest that knowing the meaning of facial signals would have adaptive value for children who are not yet verbally expressing themselves. In fact, these authors maintain that the production and recognition of facial expressions develops from the first 6 months of life (Haviland and Lelwica, 1987; Walker-Andrews and Haviland-Jones, 2005). From that point of view, the recognition of facial expressions would provide children with the basis to acquire knowledge about the causes, consequences, labels, etc. for each category of emotion (Denham, 1998).

On the opposite side, other lines of thought maintain that the experience gained in the perception of faces leads to cortical specialization (Nelson, 2001). Scientific literature indicates that there is evidence of changes in the development of emotional perception, admitting the possibility that adult patterns of emotional perception begin sometime between 8 years of age and

early adolescence. This would directly involve the perception of emotion in learning processes (Leitzke and Pollak, 2016).

Reading emotions accurately on the faces of others is the result of complex processes. Important differences in the pattern of development of recognition of different emotions have been documented between early childhood and the end of the preschool stage. Although children can produce facial expressions very early in post-natal life (Oster and Ekman, 1978; Caron et al., 1982; Haviland and Lelwica, 1987), the ability to recognize the emotions of facial expressions increases with age (Gross and Ballif, 1991; Fox, 2001; Herba and Phillips, 2004; Widen and Russell, 2007; Widen, 2012). Some studies indicate that children can identify positive facial emotions earlier and with more precision than negative ones (Camras and Allison, 1985; Boyatzis et al., 1993; Mancini et al., 2013; Widen and Russell, 2013), and its precision increases between 3 and 7 years of age (Markham and Wang, 1996; Vicari et al., 2000; Durand et al., 2007). Other studies showed that there are few interesting changes in the recognition of facial emotions after the age of 7 (Gosselin et al., 1995a) or 10 (Tremblay et al., 1987). Others reported that the recognition of facial emotions improves significantly between 6 and 15 years of age and adulthood (Vicari et al., 2000; Herba and Phillips, 2004; Herba et al., 2006; Montiroso et al., 2010). Gagnon et al. (2014) describe, on the other hand, that facial expressions of happiness, anger and sadness are recognized at an earlier age than those of fear, surprise and disgust.

Widen (2012) stated that the different conceptualization for each emotion is a key development task that occurs thanks to the addition of components for the constitution of emotional scripts. From the "dissociated widths hypothesis" approach, children could begin to differentiate fear from its extended negative valence category by adding fight and flight related components. Thus, the categories would not emerge fully formed but would gradually, one component at a time, change over the course of development and, in its final adult form, show some variation with culture and language.

In two different research papers, Gao and Maurer (2009, 2010) provided further evidence that children show slow development in emotion recognition and that this ability increases with age. These researchers used sets of stimuli differentiated by intensity (20 levels for each emotion) in children of 5, 7, and 10 years. They concluded that while 5-years-old were as skilled as adults at recognizing emotional expressions of happiness, even distinguishing between degrees of intensity in expressions, they confused those of anger, fear, and sadness. This ability increased with age, so they concluded that 10-years-old are as skilled as adults at labeling these emotions.

Perception of Emotion According to Gender

Some research suggested that there are gender differences in cognitive processes and in the recognition of facial expressions (Tiedens, 2001). The results of the studies carried out by Hall et al. (1999) showed that women seem to have a better ability to recognize facial expressions. Regarding the recognition of

emotional facial expressions according to sex, the descriptive data from a study with university students showed a tendency for women to recognize expressions of happiness more easily, while men seem to recognize expressions of anger more easily. According to these data, women show a greater tendency to recognize an expression that denotes happiness (Oyuela Vargas and Pardo Vélez, 2003). On the other hand, Wild et al. (2001) showed that women perceived faces with expressions of disgust and fear more quickly than men.

Navarro et al. (2002) carried out a study of emotion recognition in children in Colombia. They tried to find differences in the recognition of happiness, anger, sadness and fear in children between 7 and 8 years old. They concluded that there are no significant differences in the recognition of these emotions according to the gender or age of the participants. These results contrast with those obtained by Ceja and Pérez (2002), who found differences in the recognition of facial expressions according to gender, and even, according to the cultural context (Brazil or Colombia). Navarro et al. (2002) confirmed this difference and documented it in other studies carried out in the Colombian context (Acosta and Villamil, 2001, cited by Navarro et al., 2002).

MATERIALS AND METHODS

Methodology

In this investigation, a stratified probability sampling was used, that is, each member of the population had the same probability of being elected, making a call through local social networks and the media, television, radio and graphic networks. From the city, to which 60 schools responded; Eight schools were separated, using random numbers, so that each school element had the same probability of being included in the representative sample. Schools and student grades during the 2016 school year were taken as one stratum, taking all regular students from each selected grade. 214 students participated, from 1 to 6 grade from eight elementary schools in the city of Concordia, Argentina. The study had a qualitative-quantitative approach and exploratory, descriptive and correlational fields.

Instrument Design and Construction

First Phase: Purpose of the Test

After the first specialized literature review, the research unit and research variables were selected. Following this, a research problem was developed, whose theoretical objectives, justification and framework required a review of the previously used techniques and previously obtained results. Once it became clear that there were no sufficiently validated devices available, the research design required the determination of a sample and the construction of an instrument to evaluate and measure the childrens' performance in the recognition of basic emotions in the facial expressions of their peers. A new specialized review allowed selecting the basic items (variables, indicators, categories) of the instrument and the ideal conditions for its administration and data processing.

Second Phase: Design and Construction of the Test

The basic items and the structure of the test were defined to produce the reagents. Research by Boyatzis et al. (1993), Thomas et al. (2007), Gao and Maurer (2009), Widen (2012), Golan et al. (2015) guided the development of the items, which were subjected to qualitative and quantitative analysis using different strategies, qualities, indicators and criteria.

A total of 33 photographs of two models (one female and one male) of 11 years of age were selected. Both models represented facial expressions of happiness, sadness, disgust, fear and anger at three levels of intensity (low, medium, and high), based on morphological points considered by the pre-existing literature (Ekman and Friesen, 1976). The 33 photographs were selected from a total of 7,000 shots taken by certified professionals using a Canon 6 d camera + 24 105 lenses.

The intensity of a facial expression was determined by the amount of muscle displacement away from a neutral state, according to the work of Hess et al. (1997). The models were trained by a specialist neuropsychologist for 2 weeks, in sessions of 2 h a day, through the program Mental Reading: The interactive guide to emotion at the University of Cambridge.

During the shots, the representation of each of the categories was indicated (high intensity happiness, medium intensity happiness, low intensity fear, etc.) using photographs, videos and photographs as reference resources for the facial gesture intended to photograph.

Third Phase: Evaluation by Judges

Reagents were selected by a psychologist and a medical psychiatrist, specialists in Neurodevelopment and Social Cognition, which were then evaluated by a committee of experts that was made up of psychologists, psycho-pedagogues, speech pathologists, neuro-pediatricians and child and youth psychiatrists; all with extensive clinical experience in working with children. A first agreement approved 89% of the elements. Unapproved products were redesigned until each reagent could express the indicated intensity and emotion gradient.

The presentation of the preliminary version with the selected reagents tried to establish, in the first place, the unidimensionality, clarity and relevance of those reagents; then their degree of understanding for the "average primary student" of the region; and finally the need to make some modification for its optimization. Then a unified version of the test was obtained from the observations made by the judges during the preliminary phase.

Phase Four: Writing New Elements

Once the experts evaluated the quality of the instrument, the necessary adjustments were made to the items criticized in response to the psychological and sociocultural characteristics of the individuals in the sample, in order to provide the instrument with the greatest possible sensitivity. Therefore, a pilot test version was produced. The facial emotion recognition device was implemented using experimental software designed *ad hoc*. This software consisted of a successive series of slides presenting, one at a time, faces, whose correspondence with one of the

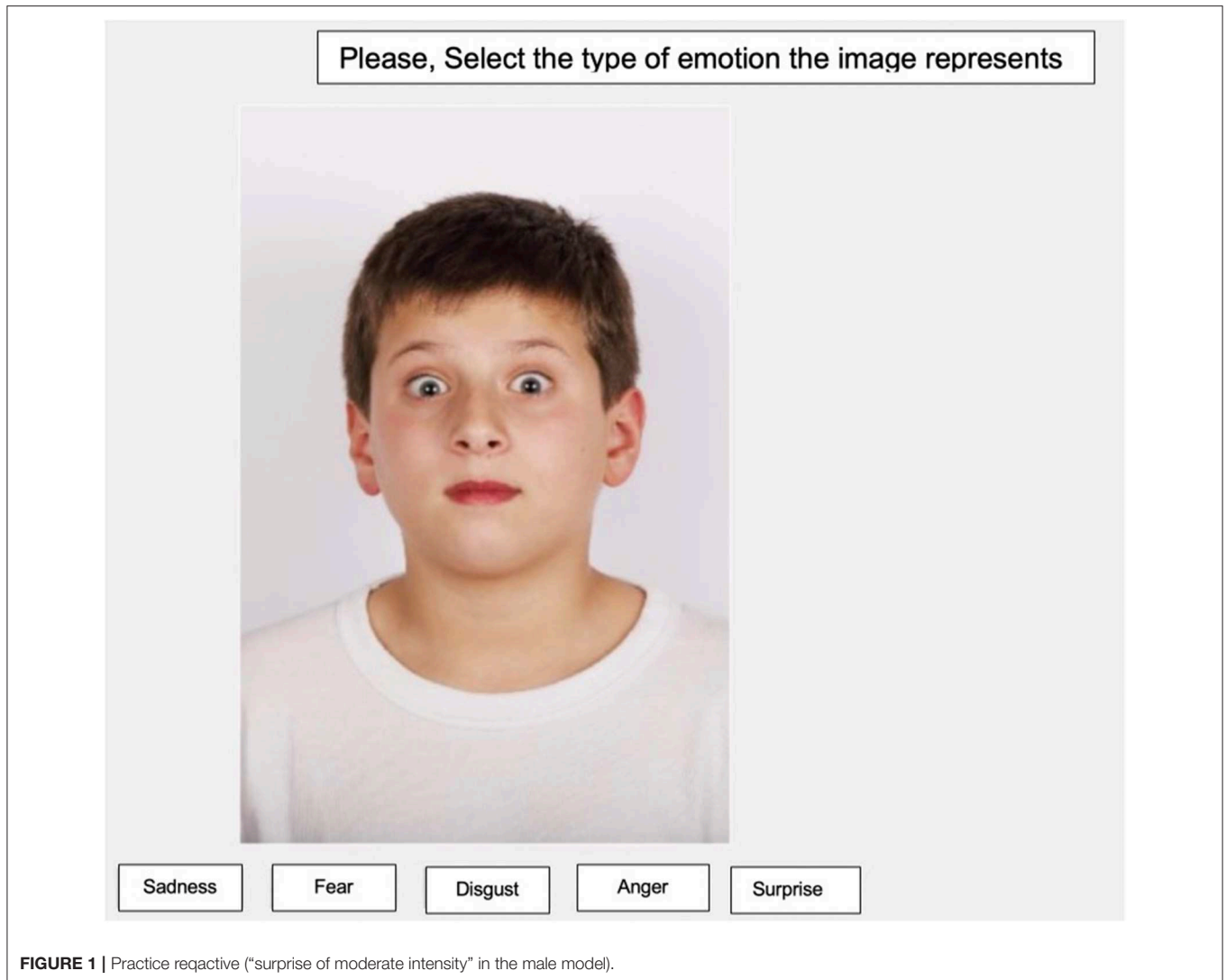


FIGURE 1 | Practice reagentive (“surprise of moderate intensity” in the male model).

five suggested labels at the bottom of each image should be selected by each individual in the sample. The instructions and three exemplary elements, related to the surprise reagent in three different intensities produced by the male actor, preceded the series. Each participant, once they have selected a label, must indicate the confidence level of their response. The program also measured executive processing time for resolution of each item. The stimuli were played in random order to eliminate the possible end of list effect.

Figure 1 corresponds to one of the practice slides (“surprise of moderate intensity” in the male model). **Figure 2** captures the stimulus screen in which the subject is consulted regarding the level of confidence with which he issues his response. **Figures 3, 4** present other examples, this time of the female model corresponding to the low and high intensity facial expressions of fear and happiness, respectively.

Fifth Phase: Pilot Test

To assess the level of understanding of the test, it was administered to 30 children, 15 males, and 15 females, from six

school groups (1st, 2nd, 3rd, 4th, 5th, and 6th grades of primary). The parents gave their written consent, while the children gave it verbally before participating in the pilot test.

The children were randomly selected from a public elementary school. The application of the instrument was individual. The tasks were performed with two laptops. To avoid the effects of confusion due to reading difficulties, experimenters read the instructions and possible responses to children, making sure they are familiar with all categories.

After each child selected a label and before continuing with a new reagent, they were asked about the level of confidence. The correct answers were not indicated to the participating children during the task. The products corresponding to each element included in the test were those that allowed each emotion, at its three levels and for the faces of the actors of girls and boys, to be recognized by at least 50% of the participants, also ensuring that none of the reagents was recognized by <20% of the examined subjects.

Based on the results of this pilot test, new adjustments were made that configured the final version of the instrument.

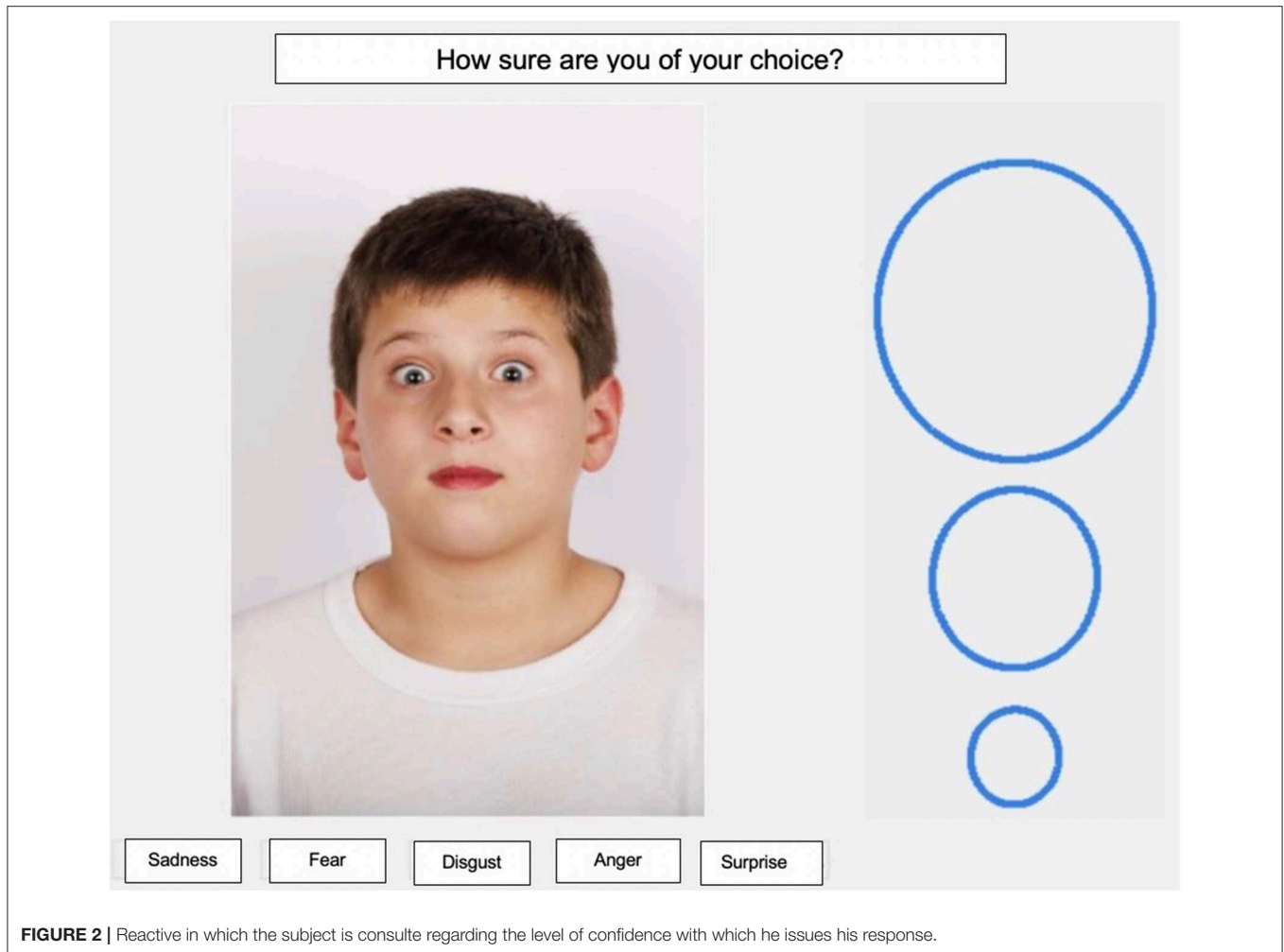


FIGURE 2 | Reactive in which the subject is consulte regarding the level of confidence with which he issues his response.

Products that did not meet these criteria were combined with new sheets and 37 children were run in a different group until all items met the criteria. The final test included 30 items for facial recognition of five basic emotions at three intensity levels for each gender. Three examples of stimuli were added with a total of 33 articles.

Sixth Phase: Psychometric Analysis

Based on data collected from the pilot test application, an analysis was performed to determine the most discriminatory and least discriminatory elements, so that both the reliability and the validity of the instrument increased once the adjustments had been made and the final version of the test was produced.

Seventh Phase: Application and Analysis of the Final Version

This phase involved administering the test to the study sample and analyzing the items, the corresponding reliability and validity.

Participants

The sample, of a homogeneous type, was made up of 214 children, aged between 6 and 12.11 years. The average age was 9.13 ± 1.86 years. 55.4% were men and 44.86% women. All the participants were students from eight public and private management primary schools, in the city of Concordia, Entre Ríos province, Argentina (see **Table 1**).

Materials

The Basic Emotion Recognition in Childhood Test (REBEC) was administered individually to each child in the sample for an average of 20 min. One point was awarded for each correct answer. The maximum score for the determination of the emotion shown was 30 points.

Data Analysis

The Matlab R2012a program (MathWorks, Natick, Massachusetts) was used to analyze and process the data. With a customized routine, the files of each subject were read, placing all the data in a single matrix.

To identify whether one genre of the reagent is more recognized than the other, a chi-square test was performed

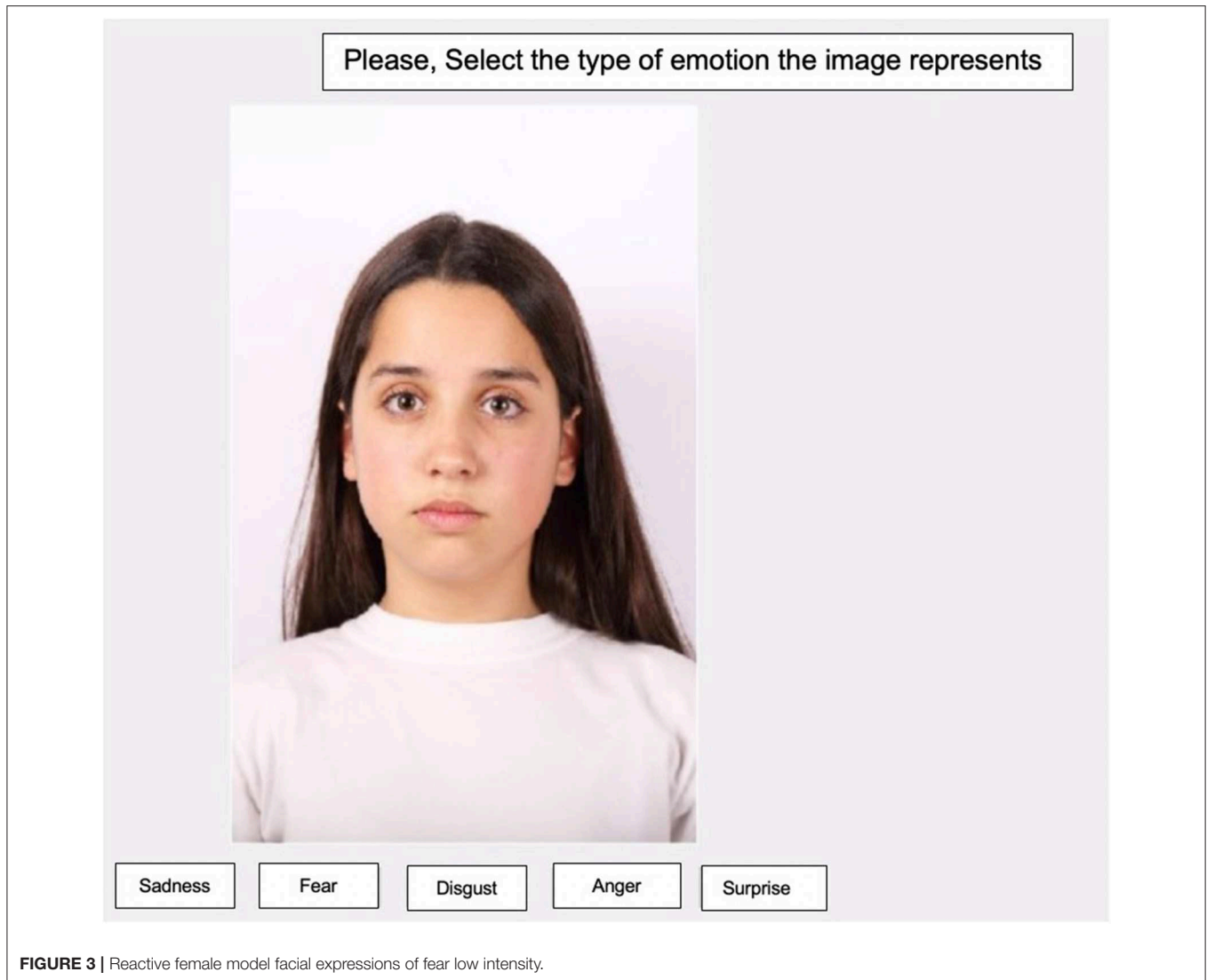


FIGURE 3 | Reactive female model facial expressions of fear low intensity.

comparing the number of subjects that recognized more reagents of the actor than the actress vs. the number of subjects that recognized more reagents of the actress than of the actor.

With the purpose of assessing the significance of the Age and Emotion variables, an ANOVA of Repeated Measures was performed with the Age between subjects variable, and the Intra-subject Emotion variable. Since an interaction Age * Subject Not significant was obtained, the main effects were analyzed. Multiple comparisons were made for the Emotion variable (regardless of the Age variable), after applying the Bonferroni correction. Since 10 comparisons were made (Joy vs. Sadness, Joy vs. Fear, etc.), Bonferroni's correction required defining as alpha of each test = global alpha/number of comparisons = $0.05/10 = 0.005$. To compare the main Age effect, multiple comparisons were run with the Tukey-Kramer correction, keeping the overall error at 0.05.

Then, for each Emotion an ANOVA of a factor was applied, with the variable Age between subjects. If the test was significant, a Dunnett *post-hoc* test was applied to compare each Age vs. 12

years (control group). The tests were considered significant if a Type I (alpha) Error of <0.05 was made.

RESULTS

For the sample under study, the average number of hits (M) was 19.86; with a standard deviation (DS) of 4.12. A significant emotion factor was obtained ($p < 0.001$), a significant age factor ($p \times 0.001$) and an emotion interaction * non-significant age ($p \times 0.24$).

The sample under study was divided into 7 age groups (6A, 7th, 8th, 9th, 10th, 11th, and 12th). Comparison of Tukey—Kramer *post-hoc* was performed to determine significant differences between the groups. The group of 12-years-old subjects achieved the highest performance with an average of 22.18×4.12 . The group of 6-years-old achieved the lowest performance with an average of 17.78×4.41 , showing a significant difference of $p < 0.05$.

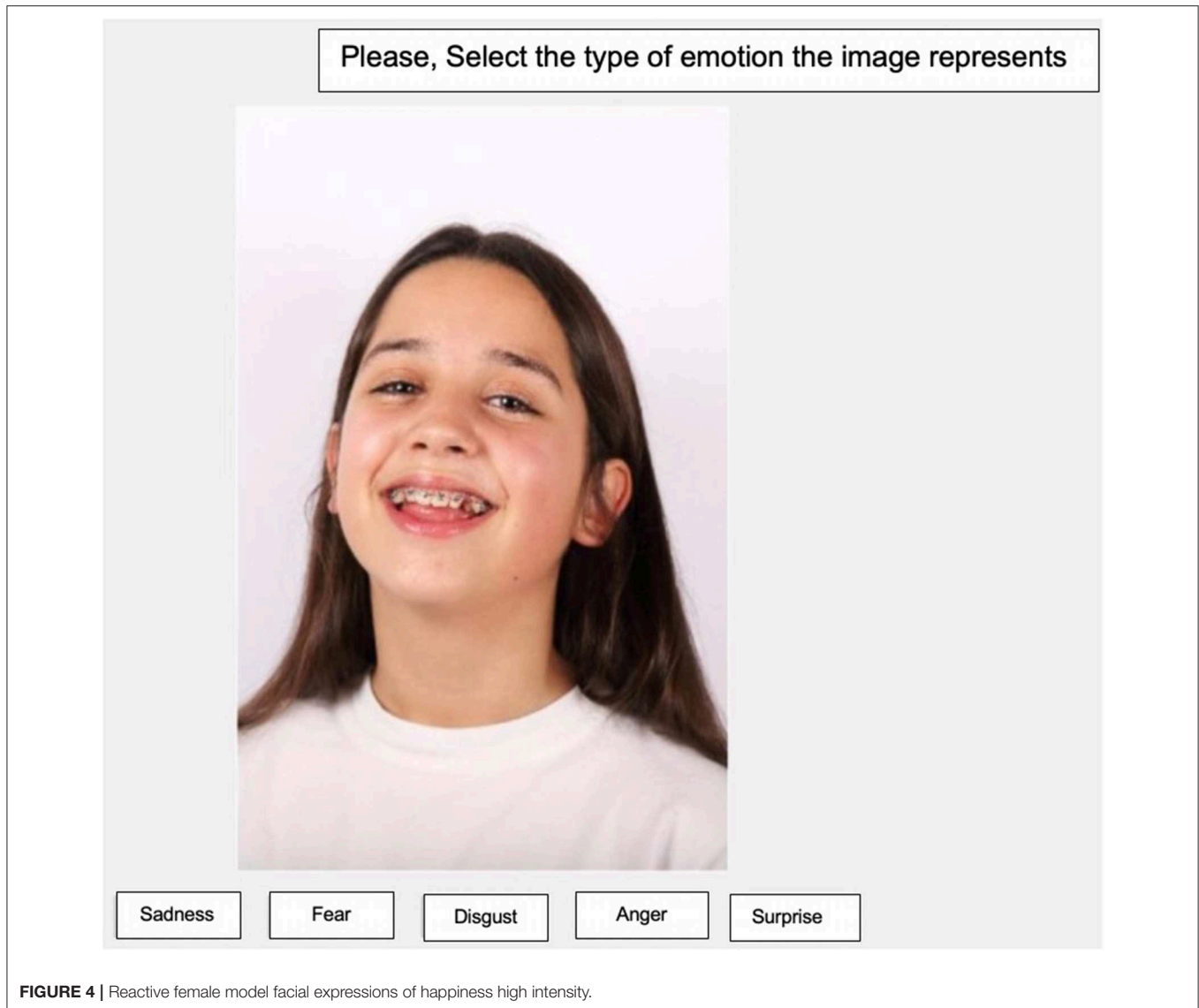


FIGURE 4 | Reactive female model facial expressions of happiness high intensity.

TABLE 1 | Demographic data by age and sex.

Age (years)	Male (n)	Females (n)	Total (n)
6	16	7	23
7	18	7	25
8	20	16	36
9	19	14	33
10	19	14	33
11	19	23	42
12	7	15	22
Total	118	96	214

The average number of hits (M) was 19.86; with a standard deviation (SD) of 4.12. The sample was divided into 7 age groups (6th, 7th, 8th, 9th, 10th, 11th, and 12th). A *post-hoc*

comparison of Tukey—Kramer was performed to determine significant differences between the groups. The group of 12-years-old achieved the highest performance with an average of 22.18 (DE × 4.12). The group of 6-years-old achieved the lowest performance with an average of 17.78 (DE × 4.41). A significant difference of $p < 0.05$.

The reported data are relative to 66.2% of the total test reagents with an 13.8% ED. The probability of being categorized by chance was p 's 3.4264 e-118. The total number of correct responses for the female sex averaged 20.61 DE × 3.91, while it was 19.24 (DE × 4.21) for the male sex. Therefore, there was a significant difference depending on the sex of the observer and there was a greater ability to recognize the basic emotions in girls ($p \times 0.016$) (see **Table 2**).

To identify whether one of the sexes of the reagent was more recognized than the other (**Figure 5**), a chi-square test was performed to compare the number of subjects who recognized more reagents of the actor than the actress compared to the

number of subjects she recognized more reactive from the actress than the actor. The absence of significant differences in the total number of successes in relation to the sex of the reagent was found ($p \times 0.19$). For the total reagents of the actor, the data collected indicated an average recognition of 65.6% ($DE \times 15.6$). The probability of being categorized by chance was p 's 1.6996 e-106 while the recognition of the total reagents of the actress averaged 66.9% ($DE \times 15.6$). The probability of being categorized by chance was p 's 7.2312 e-109. Comparing the two groups, it was concluded that both sexes were classified equally (2-sample t -test) $p \times 0.19$ (chi-square) $p \times 0.16$.

To establish possible differences in the ability to recognize emotions based on the sex of the reagent relative to the sex of the observer, the total number of successes in male reagents was

calculated minus the total number of successes in female reagents for male observers. It was determined that an average of hits of -0.30 ($DE -2.09$). In addition, the total number of female observer successes for male reagents was calculated minus total successes for female reagents. The average number of hits was, in this case, -0.07 ($DE -2.33$). A result of $p -0.46$ was obtained. No significant differences were found.

It was possible to determine that the reagents corresponding to happiness were the most recognized ($M \times 93.8\%$) while those corresponding to fear were the least recognized ($M \times 47.4\%$). Between these extremes, reagents expressing anger, sadness, and disgust were placed in decreasing order (**Figure 6**).

The level of success achieved by subjects for different reagent intensities was measured without considering the different categories (emotions). A success level of $M \times 7.64$ ($SD \times 1.75$) was obtained for high-intensity reagents, of $M \times 6.89$ ($SD \times 1.67$) for the average, and 5.34 ($SD \times 1.68$) for low-intensity reagents. Through the ANOVA of repeated measurements, a significant difference was obtained [repeated measures ANOVA, $F_{(2,213)}$'s 196.15, $p < 0.001$]. To establish the possible variation of the level of success for each emotion depending on the age of the subjects (observers), an ANOVA of repeated measures was performed in relation to the variables "age" (between subjects) and "emotion" (intra-theme). A significant age factor ($p < 0.001$), a significant emotion factor ($p < 0.001$), and an interaction Age * Non-significant emotions ($p = 0.24$) were obtained.

Similarly, the level of success of each age against a control group (group of 12-years-old) was determined for a given emotion, using a Dunnett *post-hoc* test. Only in the emotions

TABLE 2 | Normative data test of recognition of emotion in childhood by age.

Group (years)	n	Minimum	Maximum	Median	SD
6	23	7	25	17.78	± 4.41
7	25	8	23	17.56	± 4.41
8	36	8	27	19.36	± 4.28
9	33	14	26	20.51	± 3.08
10	33	9	25	20.18	± 3.33
11	42	7	29	20.85	± 4.55
12	22	17	27	22.18	± 2.78
Total sample	214	7	29	19.86	± 4.12

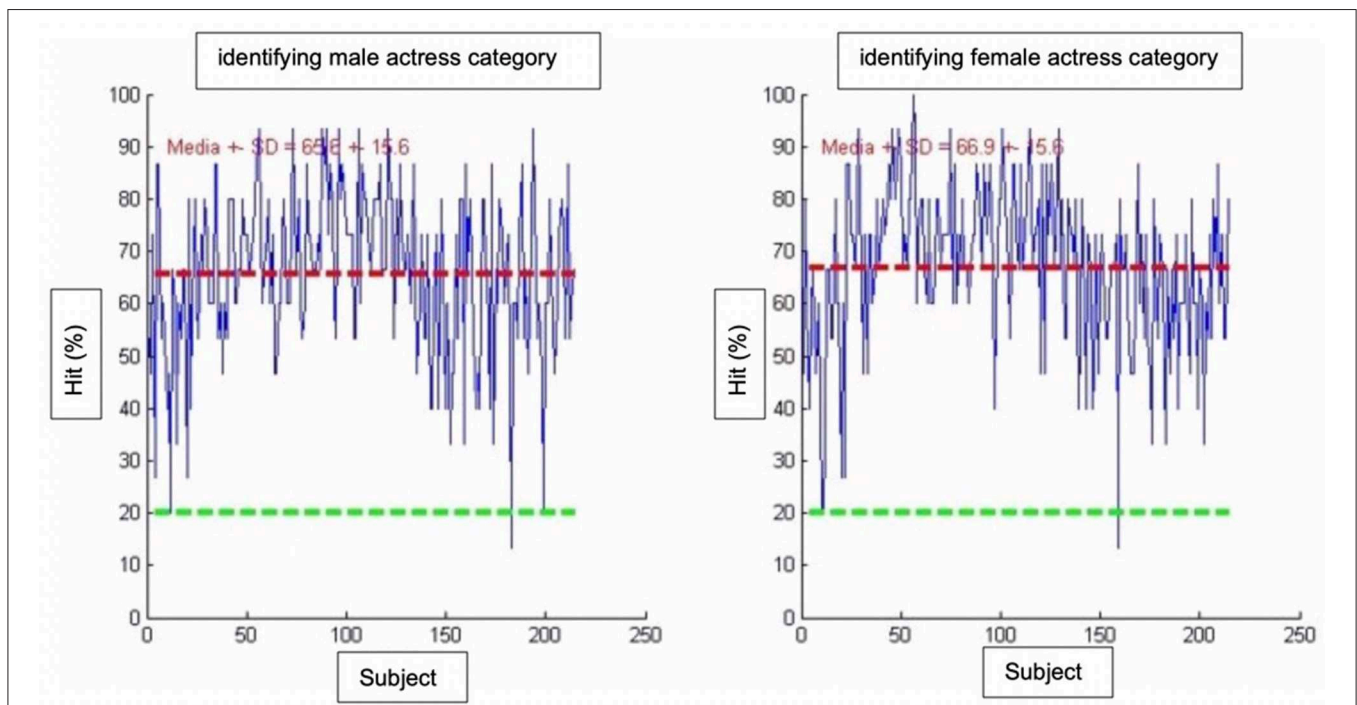


FIGURE 5 | Percentages of correct answers according to gender of the reactive.

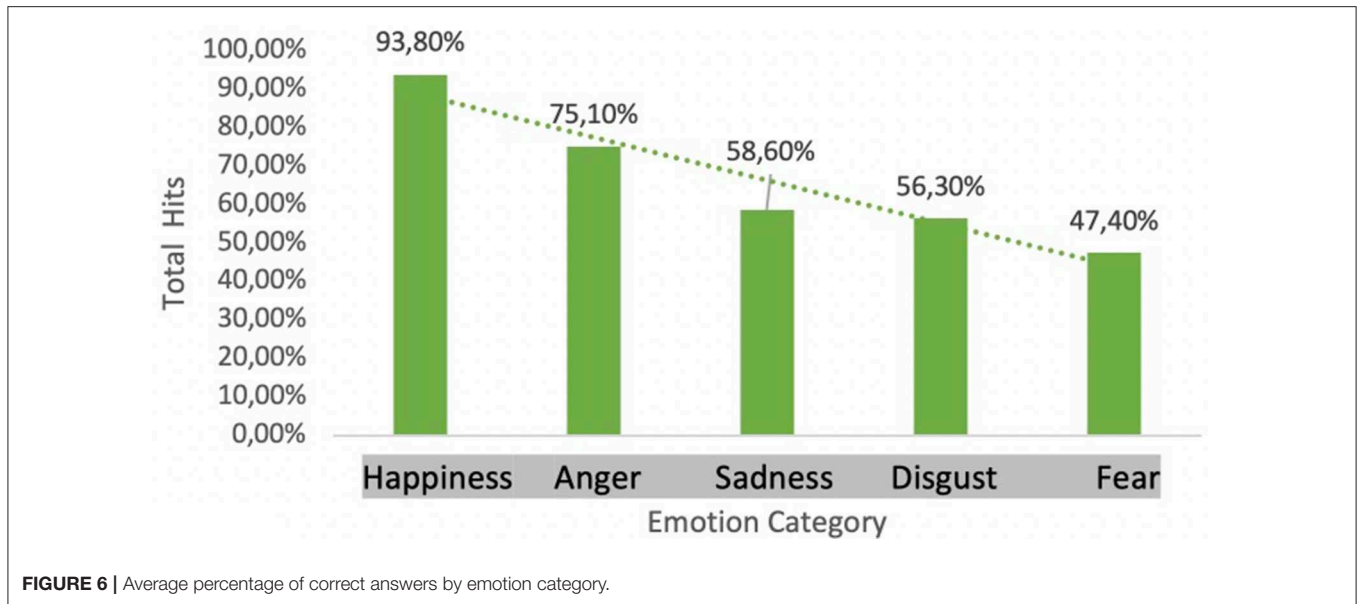


FIGURE 6 | Average percentage of correct answers by emotion category.

TABLE 3 | Comparison of significance of the age variable by category.

Dunnett test	6 vs. 12	7 vs. 12	8 vs. 12	9 vs. 12	10 vs. 12	11 vs. 12
Happiness						
Anova $p = 0.33$. Dunnett $p =$	0.37	0.46	0.69	1	1	0.69
Sadness						
Anova $p = 0.17$. Dunnett $p =$	0.83	0.09	0.99	1	1	1
Anger						
Anova $p = 0.14$. Dunnett $p =$	0.2	0.18	0.68	1	0.78	0.94
Fear						
Anova $p = 0.00$. Dunnett $p =$	0.02	0.003	0.16	0.091	0.017	0.45
Disgust						
Anova $p = 0.00$. Dunnett $p =$	0.012	0.3	0.034	0.35	0.98	1

of fear and disgust, there are significant differences from the 12th group (6th and 7th for fear, being p 's 0.02 and p 's 0.003, respectively; and for groups "6" and "8" for disgust, where p 's 0.01 and p 's 0.03, respectively; see Table 3). According to the data collected, a graph was configured with the neurodevelopmental trajectory data for each category (Figure 7).

Data collected with respect to the level of trust of subjects at the time of issuing a response indicated that, when subjects reported feeling a high level of confidence in the response made, the categorization was correct in 73.6% of cases. However, the success rate fell to 47.6% when they reported having an average confidence level and 32.4% when they reported a low level of confidence. As there were subjects who never reported medium and low confidence levels, the averages were compared by selecting those subjects who reported the three levels of confidence against any reagent ($n = 139$). When an ANOVA analysis of repeated measures with the intra-subject "confidence

level" variable was applied, success levels were recorded with significant differences ($p < 0.001$). Bonferroni's corrected *post-hoc* analysis for two comparisons showed that the level of success for the "high" confidence value was higher than for the "average" confidence value ($p < 0.001$). The level of success for the trust value was higher than for "low" trust ($p < 0.001$).

It was possible to identify for which emotions the level of recognition was significantly incorrect. In fact, children tend to confuse "sadness" with "anger" and, to a lesser extent, "fear" and "disgusting" (Figure 8). In all cases, it was found that the degree of misconception was higher the lower the intensity of the reagent.

In the case of disgust, subjects who lost recognition in relation to any of the six corresponding reagents tended to classify it as "anger" or "sadness" (Figure 9).

In the case of anger, the errors associated with female reagents were recorded with a majority relationship to the "sadness" category (9%). However, anger was mainly associated, among errors related to male reagents, with the category of disgust (14%) (Figures 10A,B).

CONCLUSIONS

The general purpose of this research was to expand knowledge about the Recognition of Emotions in Children, as a subcomponent of social cognition. From a systematic review of the previous scientific literature, the main objective arose, to describe the behavior of the variable recognition of basic emotions in third pairs in relation to sex, the intensity of the reagent and the valence of it, trying to overcome some of the limitations indicated in the bibliographic compilation. To do this, we focused on the study of recognition of basic emotions as skills (REBH) and carried out the design of an instrument that would allow us to meet the goal. In the above study, we explore

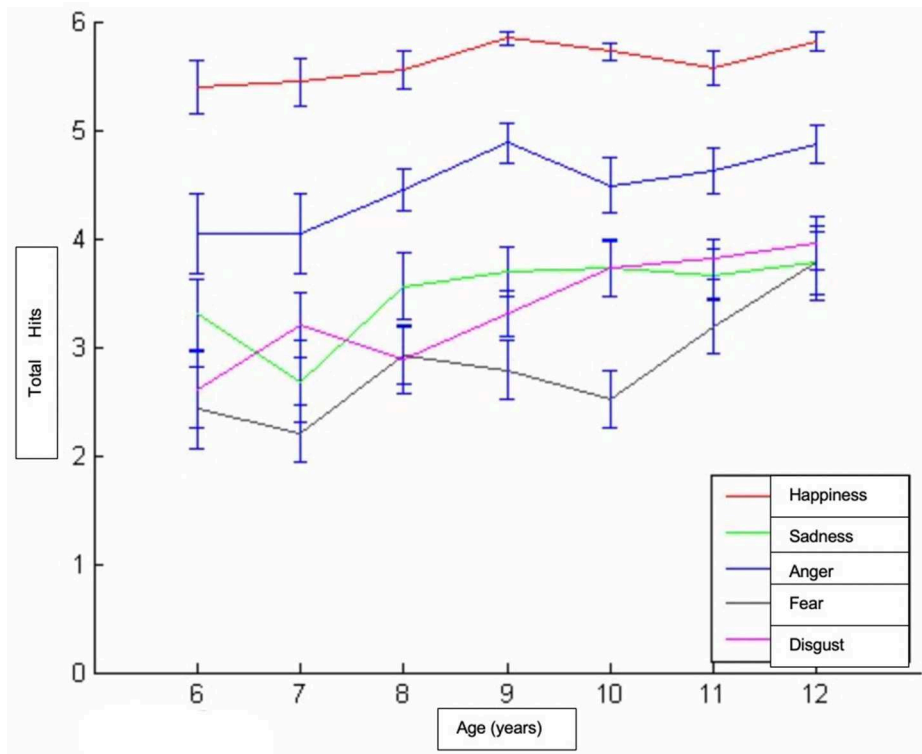


FIGURE 7 | Developmental trajectory for each emotional category.

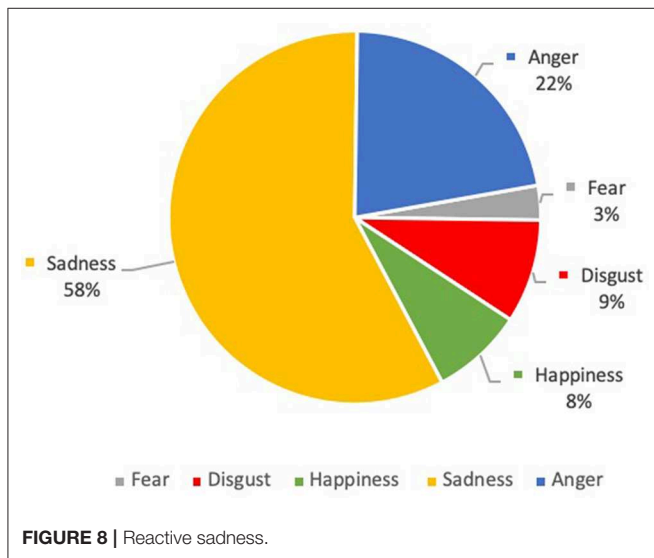


FIGURE 8 | Reactive sadness.

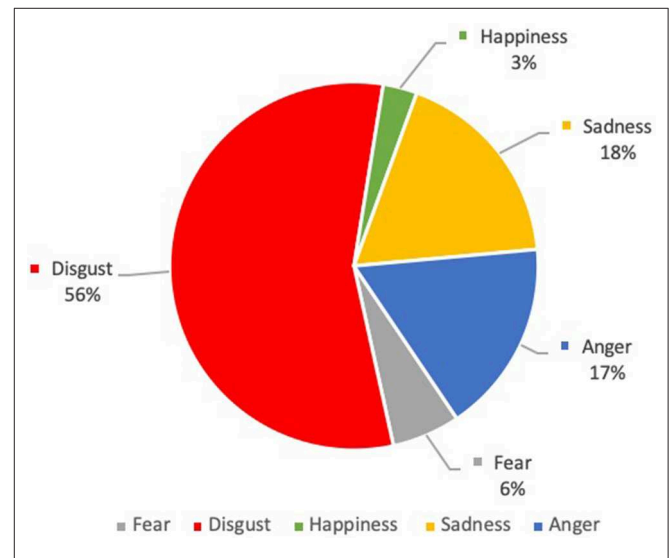
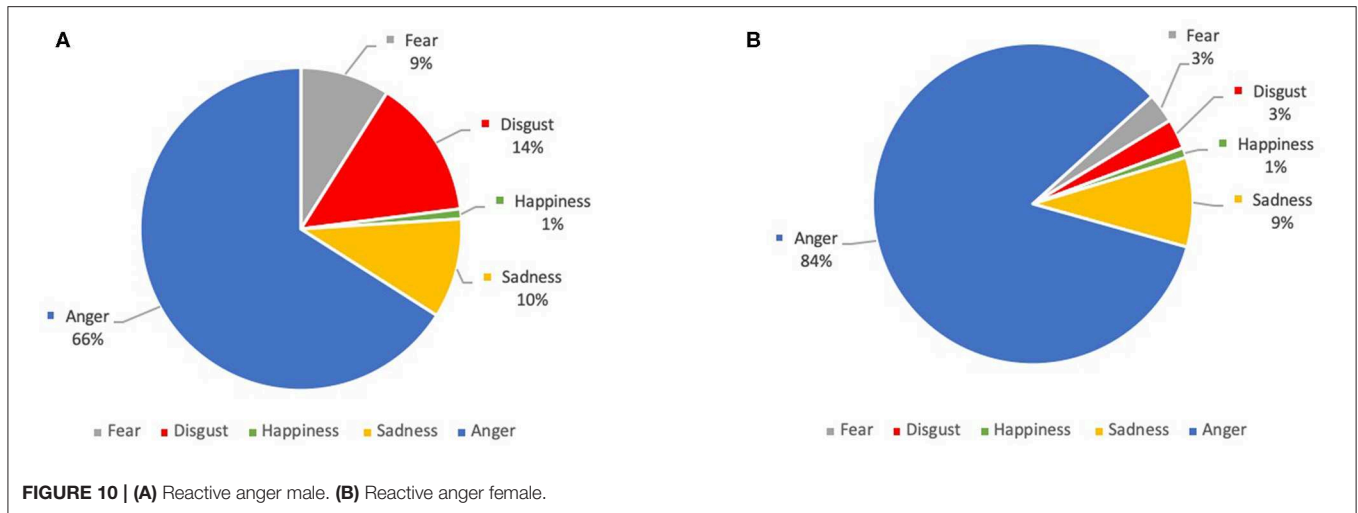


FIGURE 9 | Reactive disgust.

the relationship between REBH and age in children at the cross-sectional level, and analyze the incremental validity of REBH in the variables age, valence, gender, and emotional category.

From the results obtained, we could conclude that the sensitivity for the recognition of basic emotions in pair third parties differs according to the age of the subject evaluated for the categories corresponding to the facial expressions of fear

and disgust; however, for the other emotions, no significant differences were visualized between the groups. The female gender was shown to have a higher REBH than the male gender in the study sample. The intensity of the reagents was perceived as a determining factor in all categories; Reagents that expressed low-intensity emotions, than medium-high ones, are significantly



less recognized, except in the category of joy. Sensitivity for the recognition of basic emotions also differed according to the category of the reagent, where the stimuli corresponding to joy were the easiest to recognize, secondly, those of anger, sadness, disgust and, finally, fear. In the last two cases, children were shown to achieve recognition of 50% of reagents after age nine.

The scales of the Basic Emotion Recognition Test in Children, which was considered appropriate for the measurement of the trajectory of REBH Neurodevelopment in children aged 6–12 years, were obtained, confirming the hypothesis that the REBI Test, for its psychometric properties and sensitivity for the detection of group differences, is postulated as a valid and reliable measure for measuring skills in the recognition of facial expressions of basic emotions at three levels of Intensity.

DISCUSSION

The research sought to describe the behavior of variable recognition of basic emotions in third pairs in relation to sex, the intensity of the reagent, its valence and emotional category.

The results obtained show a clear relationship between REBH and age for the categories of fear and disgust, to a lesser extent for sadness; and a weaker one for joy and anger. The findings mentioned are consistent with those described by Mancini et al. (2013), who demonstrated that expressions of joy and anger were the most recognized, followed by those of sadness, disgust and fear. As in the work mentioned above, the last two categories were significantly less recognized than the other emotions and, the first three are recognized at younger ages, as also described by Gagnon et al. (2014). Our results are also consistent with those of Vicari et al. (2000), who reported that fear was the worst recognized emotion; however, in this last work, black-and-white photographs were used in a pencil and paper task.

Coincidentally with Gao and Maurer (2009, 2010), we find that while 6-years-old are as capable as teenagers to recognize emotional expressions of joy, distinguish between degrees of expression intensity, confuse anger in the early years of life.

Unlike the aforementioned research, our findings indicate a difference in the emotion selected with primacy in case of equivocation, depending on the gender of the reagent, being the sadness in the case of the female reagent and disgust in the male. As in previous works, such as those of Thomas et al. (2007), Gao and Maurer (2009)—focused only on fear and anger; Gordillo et al. (2015), we were able to determine that REBH increases with age, concluding that 10-years-old are as capable as those of later ages to label basic emotions. It should be noted that the above studies were conducted with smaller samples than that of this research (72, 31, and 47 children, respectively), using reagents with images of adults in the last two cases.

Our results show that children can recognize happy expressions of high intensity with the high precision rates observed in adolescents and adults at 6 years of age, according to Camras and Allison (1985), Boyatzis et al. (1993), Gao and Maurer (2009, 2010); and Widen and Russell (2013). We also found that children at 6 years old were as accurate as adults in recognizing intense sadness, a finding consistent with the previous ones (Vicari et al., 2000; Durand et al., 2007; Gao and Maurer, 2009, 2010). However, as the intensity of the items decreased, the confusion with fear in the aforementioned works was greater, unlike ours, in which the items selected in the case of misunderstandings were those of anger. However, these results would not be exactly different according to the contributions of Widen (2012), who states that, in children, the understanding of facial expressions and other aspects of the face is broad and based on valence. For children at a young age, angry and sad would correspond to a broad category of negative emotion and would mean something like “feels bad,” so they would use this label for all negative facial expressions. With increasing age and experience, children would differentiate this broad initial category, and anger would be used for anger and disgust, and sadness for sadness and fear. We agree with some of these works that maintain that this lack of sensitivity could limit the ability of children to identify with others and monitor the impact of their deficiencies on parents and teachers; Identifying a sad face as angry can cause inappropriate action.

In relation to gender and a higher REBH, our results are consistent with those found so far, where the female gender is postulated with better results in the emotion labeling tests (Rotter and Rotter, 1988; Boyatzis et al., 1993; Hall et al., 1999; Wild et al., 2001) and oppose those who did not find significant differences according to the gender of the observer, as described by the works of Navarro et al. (2002) and those of Leitzke and Pollak (2016).

STUDY LIMITATIONS

This research shows some limitations that should be considered especially when generalizing results. Most of the results obtained are cross-cutting in nature, so it is not possible to draw solid conclusions about the temporal relationship between the variables under study. In such a case, it would be necessary to corroborate these results at a prospective level.

On the other hand, when considering the study of some cognitive processes, the evaluation of the IQ of the participants was not included. Although these data could be considered as control information to determine inclusion criteria, the above literature does not consider differences in the intellectual level, and even authors, such as Araya et al. (2009) considered both processes to be independent. However, there is a possibility that HF is a factor that can help explain some of the results obtained.

In future research, it would be relevant to extend this line of work by concluding scientific cooperation agreements to increase the number of subjects investigated, in order to increase the reliability of the results; correlate the data obtained with other subcomponents of various cognitive functions, as well as consider generating lines related to longitudinal research, involving the application of emotional education programs, in order to evaluate the possible modification in recognition after exposure to training programs in the recognition of facial expressions.

PRACTICAL IMPLICATIONS

The importance of studying children's ability to discriminate emotions stems from their involvement in emotional regulation. This process is built on basic cognitive control and requires adequate ability to discriminate emotions (Tottenham et al., 2011). In this case, children should adequately discriminate against emotions before they can regulate them.

A deficit of this capacity can lead to problems of social adaptation and be a risk factor for the development of psychopathologies in adulthood (Herba and Phillips, 2004; Batty and Taylor, 2006). In this sense, emotions would participate in both the learning process and academic performance (Schunk et al., 2008), and it is through the regulation of the emotional processes that the child can acquire the skills necessary to be effective in school. Graziano et al. (2007) found that subjective parent information about their children's emotional regulation was a significant predictor of performance in mathematics and

language. In addition, children's increased ability to regulate their emotions is related to increased interaction with other children and teachers and therefore to a lower likelihood of behavioral problems.

Based on available evidence, emotional education in children could be considered a form of non-specific primary prevention (Bisquerra and Pérez, 2012), as it involves a number of capacities applicable to the various demands in different contexts of an adult individual. Effective prevention of dysfunctions in the future social life of today's children depends on appropriate educational intervention in terms of emotions and social cognition. It is crucial, therefore, to understand the time intervals that determine the correct acquisition of emotional discrimination skills, which, together with proper cognitive development, could influence the processes of emotional regulation, regulation that, in turn, enables children to adapt to the educational and social field. Several authors documented that positive emotions improve learning by increasing persistence, strategy and recruitment of cognitive resources (Pekrun et al., 2002; Sabourin and Lester, 2014; Verkijika and De Wet, 2015) and that negative emotions, such as anxiety, have the opposite effect (Meyer and Turner, 2006; Sabourin and Lester, 2014; Verkijika and De Wet, 2015).

Actions to promote, prevent and care for mental, educational and social health should have priority attention to the development of emotions in children at normal and pathological levels. The design and validation of appropriate diagnostic instruments should be a central chapter in this horizon of challenges. Developments in this field of research will enable the collection of more reliable evidence to find efficient early care and education interventions.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Doctorate from Maimonides University in Psychology with guidance in Applied Cognitive Neuroscience, Buenos Aires, Argentina. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

VP and FR contributed to the conception, design of the study, and wrote the first draft of the manuscript. VP organized the database and performed the statistical analysis. Both authors contributed to the article and approved the submitted version.

REFERENCES

- Araya, K., Araya, C., Chaigneau, S., Martínez, L., and Castillo, R. (2009). La influencia de los procesos controlados en el razonamiento con Teoría de la Mente (ToM) en niños con y sin discapacidad intelectual. *Revista Latinoamericana de Psicología* 41, 197–211.
- Batty, M., and Taylor, M. J. (2006). The development of emotional face processing during childhood. *Dev. Sci.* 9, 207–220. doi: 10.1111/j.1467-7687.2006.00480.x
- Bisquerra, R., and Pérez, N. (2012). Educación emocional: estrategias para su puesta en práctica. *Revista de la Asociación de Inspectores de Educación de España* 16, 1–11.
- Boyatzis, C. J., Chazan, E., and Ting, C. Z. (1993). Preschool children's decoding of facial emotions. *J. Genet. Psychol.* 154, 375–382. doi: 10.1080/00221325.1993.10532190
- Bullock, M., and Russell, J. A. (1985). Further evidence on preschooler's interpretations of facial expressions. *Int. J. Behav. Dev.* 8, 15–38. doi: 10.1177/016502548500800103
- Camras, L. A., and Allison, K. (1985). Children's understanding of emotional facial expressions and verbal labels. *J. Nonverbal. Behav.* 9, 84–94. doi: 10.1007/BF00987140
- Caron, R. F., Caron, A. J., and Meyers, R. S. (1982). Abstraction of invariant face expressions in infancy. *Child Dev.* 53, 1008–1015. doi: 10.2307/1129141
- Ceja, V. S., and Pérez (2002). *Descriptive comparative study between Colombian and Brazilian children on the recognition of basic emotional expressions such as component of emotional intelligence*. Pontificia Universidad Javeriana, Faculty of Psychology.
- Damasio, A. R. (1994). *Descartes's Mistake: The Reason for Emotions*. Santiago: Andrés Bello.
- Darwin, C. (1873). *The Expression of Emotions in Animals and Man*. New York, NY: Appleton.
- Denham, S. A. (1998). *Emotional Development in Young Children*. New York, NY: Guilford.
- Durand, K., Galloway, M., Seigneuric, A., Robichon, F., and Baudouin, J. (2007). The development of facial emotion recognition: the role of with gural information. *J. Exp. Child Psychol.* 97, 14–27. doi: 10.1016/j.jecp.2006.12.001
- Ekman, P. (2003). *El rostro de las emociones*. Barcelona: RBA.
- Ekman, P., and Friesen, W. V. (1976). Measuring facial movement. *J. Environ. Psychol.* 1, 56–75. doi: 10.1007/BF01115465
- Ekman, P., Friesen, W. V., O'Sullivan, M., Chan, A., Diacoyanni-Tarlatzis, I., Heider, K., et al. (1987). Universals and cultural differences in the judgments of facial expressions of emotion. *J. Pers. Soc. Psychol.* 53, 712–717. doi: 10.1037/0022-3514.53.4.712
- Fox, J. (2001). *Identifying Emotions in Faces: A Developmental Study*. Washington, DC: Intel Science Talent Search. Retrieved from: psych.nyu.edu/pelli/docs/JeremyFoxIntel.pdf
- Gagnon, M., Gosselin, P., and Maassarani, R. (2014). Children's ability to recognize emotions from partial and complete facial expressions. *J. Genet. Psychol.* 175, 416–430. doi: 10.1080/00221325.2014.941322
- Gao, X., and Maurer, D. (2009). Influence of intensity on children's sensitivity to happy, sad, and fearful facial expressions. *J. Exp. Child Psychol.* 102, 503–521. doi: 10.1016/j.jecp.2008.11.002
- Gao, X., and Maurer, D. (2010). A happy story: developmental changes in children's sensitivity to facial expressions of varying intensities. *J. Exp. Child Psychol.* 107, 67–86. doi: 10.1016/j.jecp.2010.05.003
- Golan, O., Sinai-Gavrilov, Y., and Baron-Cohen, S. (2015). The cambridge mindreading face-voice battery for children (CAM-C): complex emotion recognition in children with and without autism spectrum conditions. *Mol. Autism* 6:22. doi: 10.1186/s13229-015-0018-z
- Gordillo, F., Pérez, M., Arana, J. M., Mestas, L., and López, R. M. (2015). Role of experience in the neurology of facial expression of emotions. *J. Neurol.* 60, 316–320. doi: 10.33588/rn.6007.2014403
- Gosselin, P., Kirouac, G., and Doré, F. Y. (1995a). Components and recognition of facial expression in the communication of emotion by actors. *J. Pers. Soc. Psychol.* 68, 83–96. doi: 10.1037/0022-3514.68.1.83
- Gosselin, P., and Larocque, C. (2000). Facial morphology and children's categorization of facial expressions of emotions: a comparison between Asian and caucasian faces. *J. Genet. Psychol.* 161, 346–358. doi: 10.1080/00221320009596717
- Gosselin, P., Roberge, P., and Lavallée, M. (1995b). Le développement de la reconnaissance des facial expressions émotionnelles du répertoire humain. *Enfance* 48, 379–396. doi: 10.3406/enfan.1995.2144
- Graziano, P., Reavis, R., Keane, S., and Calkins, S. (2007). The role of emotion regulation and children's early academic success. *J. School Psychol.* 45, 3–19. doi: 10.1016/j.jsp.2006.09.002
- Gross, A. L., and Ballif, B. (1991). Children's understanding of emotion from facial expressions and situations: a review. *Dev. Rev.* 11, 368–398. doi: 10.1016/0273-2297(91)90019-K
- Hall, C. W., Gaul, L., and Kent, M. (1999). College students' perception of facial expression. *Perceptual and Motor Skills* 89, 763–770.
- Haviland, J., and Lelwica, M. (1987). The induced affect response: 10-week-old infants' responses to three emotion expressions. *Dev. Psychol.* 23, 97–104. doi: 10.1037/0012-1649.23.1.97
- Herba, C., and Phillips, M. (2004). Annotation: development of facial expression recognition from childhood to adolescence: Behavioural and neurological perspectives. *J. Child Psychol. Psychiatry* 45, 1185–1198. doi: 10.1111/j.1469-7610.2004.00316.x
- Herba, C. M., Landau, S., Russell, T., Ecker, C., and Phillips, M. L. (2006). The development of emotion-processing in children: effects of age, emotion, and intensity. *J. Child Psychol. Psychiatry* 47, 1098–1106. doi: 10.1111/j.1469-7610.2006.01652.x
- Hess, U., Blairy, S., and Kleck, R. (1997). The intensity of emotional facial expressions and decoding accuracy. *J. Nonverbal Behavior* 21, 241–257. doi: 10.1023/A:1024952730333
- Izard, C. E. (1994). Innate and universal facial expressions: evidence from developmental and cross-cultural research. *Psychol. Bulletin* 2, 288–299. doi: 10.1037/0033-2909.115.2.288
- Leitzke, B. T., and Pollak, S. D. (2016). Developmental changes in the primacy of facial cues for emotion recognition. *Dev. Psychol.* 52, 572–581. doi: 10.1037/a0040067
- Mancini, G., Agnoli, S., Baldaro, B., Ricci Bitti, P. E., and Surcinelli, P. (2013). Facial expressions of emotions: Recognition accuracy and affective reactions during late childhood. *J. Psychol.* 147, 599–617. doi: 10.1080/00223980.2012.727891
- Markham, R., and Wang, L. (1996). Recognition of emotion by Chinese and Australian children. *J. Cross-Cultural Psychol.* 27, 616–643. doi: 10.1177/0022022196275008
- Meyer, D. K., and Turner, J. C. (2006). Re-conceptualizing emotion and motivation to learn in classroom contexts. *Edu. Psychol. Rev.* 18, 377–390. doi: 10.1007/s10648-006-9032-1
- Montirosso, R., Peverelli, M., Frigerio, E., Crespi, M., and Borgatti, R. (2010). The development of dynamic facial expression recognition at different intensities in 4- to 18-year-olds. *Soc. Dev.* 19, 71–92. doi: 10.1111/j.1467-9507.2008.00527.x
- Morton, J., and Johnson, M. H. (1991). CONSPEC and CONLERN: a two-process theory of infant face recognition. *Psychol. Rev.* 2, 164–181. doi: 10.1037/0033-295x.98.2.164
- Navarro, D., Rey, N., Velasco, I. C., and Pérez, M. (2002). *Diferenciación y caracterización del reconocimiento de emociones básicas en niños y niñas*. Pontificia Universidad Javeriana, Faculty of Psychology.
- Nelson, C. A. (2001). The development and neural bases of face recognition. *Infant. Child. Dev.* 10, 3–18. doi: 10.1002/icd.239
- Oster, H., and Ekman, P. (1978). Facial behavior in child development. *Minn. Symp. Child Psychol.* 11, 231–276.
- Oyuela Vargas, R., and Pardo Vélez, C. F. (2003). Diferencias de género en el reconocimientode expresiones faciales emocionales. *Univ. Psychol.* 2, 151–168. Available online at: <https://dialnet.unirioja.es/servlet/articulo?codigo=1123645>
- Pekrun, R., Goetz, T., Titz, W., and Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. *Edu. Psychol.* 37, 91–105. doi: 10.1207/S15326985EP3702_4
- Rotter, N. G., and Rotter, G. S. (1988). Sex differences in the encoding and decoding of negative facial emotions. *J. Nonverbal Behavior* 12, 139–148. doi: 10.1007/BF00986931
- Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin* 115, 102–141. doi: 10.1037/0033-2909.115.1.102

- Sabourin, J. L., and Lester, J. C. (2014). Affect and engagement in game-based learning environments. *IEEE Transactions on Affective Computing* 5, 45–56. doi: 10.1109/T-AFFC.2013.27
- Schunk, D. H., Pintrich, P. R., and Meece, J. (2008). *Motivation in Education: Theory, Research, and Applications*. Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.
- Shariff, A., and Tracy, J. (2011). What are emotion expressions for? *Curr. Direct. Psychol. Sci.* 20, 395–399. doi: 10.1177/0963721411424739
- Tarr, M. J., and Gauthier, I. F. (2000). A flexible fusiform area for subordinate-level visual processing automatized by expertise. *Nat. Neurosci.* 3, 764–769. doi: 10.1038/77666
- Thomas, L. A., De Bellis, M. D., Graham, R., and La Bar, K. S. (2007). Development of emotional facial recognition in late childhood and adolescence. *Dev. Sci.* 10, 547–558. doi: 10.1111/j.1467-7687.2007.00614.x
- Tiedens, L. Z. (2001). Anger and advancement versus sadness and subjugation: the effect of negative emotion expressions on social status conferral. *J. Personal. Soc. Psychol.* 80, 86–94. doi: 10.1037/0022-3514.80.1.86
- Tottenham, N., Hare, T. A., and Casey, B. J. (2011). Behavioral assessment of emotion discrimination, emotion regulation, and cognitive control in childhood, adolescence, and adulthood. *Front. Psychol.* 2:39. doi: 10.3389/fpsyg.2011.00039
- Tremblay, C., Kirouac, G., and Dore, F. Y. (1987). The recognition of adults' and children's facial expressions of emotions. *J. Psychol.* 121, 341–350. doi: 10.1080/00223980.1987.9712674
- Verkijika, S. F., and De Wet, L. (2015). Using a brain-computer interface (BCI) in reducing math anxiety: evidence from South Africa. *Computers & Education* 81, 113–122. doi: 10.1016/j.compedu.2014.10.002
- Vicari, S., Snitzer, J., Pasqualetti, P., Vizzotto, A., and Caltagirone, C. (2000). Recognition of facial expressions of emotions in school-age children: the intersection of perceptual and semantic categories. *Pediatr. Act* 89, 836–845. doi: 10.1111/j.1651-2227.2000.tb00392.x
- Walker-Andrews, A., and Haviland-Jones, J. (2005). A dynamic duo: emotion and development. *Behav. Brain Sci.* 28, 221–222. doi: 10.1017/S0140525X05500049
- Widen, S. (2012). Children's interpretation of facial expressions: the long path from valence-based to specific discrete categories. *Emot. Rev.* 5, 1–6. doi: 10.1177/1754073912451492
- Widen, S. C., and Russell, J. A. (2007). "Children's understanding of scripts for basic-level vs. social emotions," in *Poster Presented at the 2007 Biennial Meeting of the Society for Research in Child Development* (Boston, MA).
- Widen, S. C., and Russell, J. A. (2013). Children's recognition of disgust in others. *Psychol. Bull.* 139, 271–299. doi: 10.1037/a0031640
- Wild, B., Erb, M., and Bartels, M. (2001). Are emotions contagious? Evoked emotions while viewing emotionally expressive faces: quality, quantity, time course and gender differences. *Psychiatry Res.* 102, 109–124. doi: 10.1016/S0165-1781(01)00225-6

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2020 Poenitz and Román. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.