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FACE EXPRESSIONS IN CHILDHOOD: DEVELOPMENT OF A PICTURE SET AND INVESTIGATION OF DEVELOPMENTAL MARKERS, SOCIAL DEMOGRAPHIC MODERATORS AND LENGTH OF PRESENTATION EFFECTS

ALINE ROMANI SPONCHIADO

Dissertação apresentada ao Programa de Pós-Graduação em Psicologia da Pontifícia Universidade Católica do Rio Grande do Sul como requisito parcial para a obtenção do grau de Mestre em Psicologia.

Porto Alegre
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RESUMO

Introdução: Emoções são fundamentais em todo o desenvolvimento humano. Reconhecer expressões faciais de emoções em terceiros é uma estratégia valiosa de comunicação não-verbal e é particularmente relevante durante toda a infância, uma vez que a linguagem ainda não está plenamente desenvolvida e as primeiras interações com os pares estão começando. Apesar disso, poucos estudos focam no reconhecimento de faces em crianças e a maior parte dos trabalhos utiliza estímulos adultos, uma vez que os conjuntos de estímulos com crianças são raros. A dissertação teve como objetivo preencher esta lacuna através do desenvolvimento da Child Emotions Pictures Set (CEPS) e investigar marcadores de desenvolvimento de reconhecimento de faces emocionais em crianças com idade entre seis e 11 anos e os efeitos da idade, do sexo e do tempo de apresentação sobre ele. **Método**: A dissertação é composta por dois estudos. O estudo I foi desenvolvido de forma a ter uma base de dados completa que poderia permitir estudo II. O segundo estudo relata uma investigação empírica de marcadores desenvolvimentais de reconhecimento de faces emocionais em crianças entre seis e 11 anos e o efeito do sexo, da idade e do tempo de apresentação do mesmo. Um experimento com base no CEPS foi apresentado a 90 crianças divididas em três grupos etários (6-7 anos de idade; 8-9 anos de idade; 10-11 anos de idade) de meninos e meninas. **Resultados**: A versão final do CEPS é composta de 225 fotos de 17 crianças, meninos e meninas, com idade entre seis e 11 anos de idade, de origens multirraciais que posaram ou naturalmente expressaram as seis emoções básicas - alegria, medo, nojo, surpresa, tristeza e raiva - em três intensidades - fraca, média e forte - e neutralidade. O estudo II revelou que alegria apresenta as maiores médias de acurácia e é seguida em sequencia por: nojo, surpresa, raiva, medo e tristeza. O desenvolvimento do reconhecimento das expressões de faces emocionais denota seguir o curso cronológico da infância, contudo os resultados demonstram a inexistência de uma vantagem feminina e a duração da exposição dos estímulos não apresentam diferenças significativas. **Conclusão**: O CEPS contribui para o campo científico, disponibilizando estímulos infantis que se destina a ser utilizado em estudos de desenvolvimento e também permite o desenvolvimento de estudos transculturais no campo. Essa dissertação fornece também mais evidências sobre os marcadores de desenvolvimento do reconhecimento de faces emocionais e do curso cronológico que decorre ao longo da infância, além de demonstrar a não-existência de uma vantagem feminina nesta habilidade e que maior tempo de exposição a estímulos não facilita o reconhecimento. Este método é suscetível a replicação, permitindo o estabelecimento de marcadores de desenvolvimento do reconhecimento de expressões faciais de emoções.

Palavras-chave: reconhecimento de face; emoção; desenvolvimento; crianças; estímulos rosto definido.

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ABSTRACT

Background: Emotions are fundamental across human development. Recognizing emotional face expressions in others is a valuable strategy of non-verbal communication and is particularly relevant throughout childhood given that language skills are not yet fully developed and the first interactions with peers have just started. Despite this, few studies focus on face processing in children and most of the work uses adult face stimuli, since stimuli sets with children pictures are rare. The current dissertation aimed to fill this gap through the development of the Child Emotions Pictures Set (CEPS) and investigating developmental markers of recognition of emotional faces in children aged between six and 11 years-old and the effect of age, sex and length of presentation on it. **Methods:** The dissertation is composed of two studies. Study I was developed in order to have a complete database that could allow Study II. The second study reports an empirical investigation of developmental markers of recognition of emotional faces in children between six and 11 years-old and the effect of sex, age and length of presentation on it. An experiment based on CEPS was presented to 90 children divided in three age groups (6-7 years-old; 8-9 years-old; 10-11 years-old) of boys and girls. **Results:** The final version of CEPS consists of 225 photos of 17 children, boys and girls, aged six to 11 years-old from multiracial backgrounds posing or naturally expressing the six basic emotions – happiness, fear, disgust, surprise, sadness and anger – in three intensities – low, medium and high – and neutrality. Study II reveled that happiness had the higher means of accuracy followed in sequence by disgust, surprise, anger, fear and sadness. Development of emotional face expressions recognition denote to follow childhood chronological course, although, results demonstrate a non-existence of a female advantage length of presentation does not show significant differences. **Conclusion:** CEPS contributes for the scientific field by making available a child face stimuli set, which is intended to be used in further developmental studies and also enables the development of cross-cultural studies in the field. We also provide further evidence about developmental markers of emotional face expressions recognition and the chronological course that it follows through childhood showing the non-existence of a female advantage on this skill and that longer exposure to stimuli does not facilitate the recognition. This method is susceptible to replication, allowing the establishment of developmental markers of emotional face expressions recognition.

Key words: face recognition; emotion; development; children; face stimuli set.

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1. Presentation

The main aim of this dissertation was to investigate developmental patterns of recognition of emotional faces in children aged between six and 11 years-old. A second objective was to develop a database comprising children emotional faces.

In order to achieve the proposed goal, two empirical studies were performed. The first study describes the development of the Child Emotions Pictures Set (CEPS) – a database consisting of emotional faces of boys and girls aged between six and 11 years-old expressing the six basic emotions. The second study aimed to investigate developmental markers of recognition of emotional faces in children aged between six and 11 years-old and the effect of sex, age and length of presentation on it.

Studies described here are part of a line of research on emotional processing of GNAT, Program of Post-Graduation in Psychology at PUCRS. All the work was carried out in collaboration with the elementary schools: Professor José de Oliveira Castilhos; Gaspar Silveira Martins, Ildefonso Gomes and Anne Frank. All the ethical requirements were carefully fulfilled and the documents reporting the approval from the Ethical Committee for Research are provided at Appendices I and II.

1.1 Recognition of emotional faces in children

Emotions play an important role in several processes of human development, as establishment of social interactions (Levenson, Carstensen, Friesen, & Ekman, 1991), decision making, memory and attention (Harlé, Chang, van 't Wout, & Sanfey, 2012; Wilker, Elbert, & Kolassa, 2013). In 1872, Darwin published the book "The Expression of the Emotions in Man and Animals" presenting pioneer contributions to the field. Darwin proposes the existence of a higher order emotion category named basics. Basic emotions are defined as evolutionary adaptative, shared for all cultures (Ekman & Friesen, 1971) and associated to specific biological and physical states (Ekman, 1992; LeDoux, 2012). Specific emotions included within the basic emotions category are: angriness, fear, sadness, disgust, happiness and surprise (Darwin, 1872).

Along with the concept that basic emotions are products of communication and survival evolution, Darwin (1872) described the ability to produce facial expressions of emotions and the ability of recognize this expressions on another face. As well as basic emotions, emotional facial expressions (EFE) are thought to be stemmed from evolution of species and are shared among all cultures (Darwin, 1872; Ekman et al., 1987).

Darwin´s pioneer studies boosted an increasing interest on research of EFE (ekman et al., 1987; Gosselin & Larocque, 2000; Kendler et al., 2008), in particular because facial expressions provide relevant information about others (Rhodes & Anastasi, 2012; Sze, Goodkind, Gyurak, & Levenson, 2012), including emotional states (Thomas, De Bellis, Graham, & LaBar, 2007). Therefore, EFE recognition is a core strategy of non-verbal communication that allows adequate adaptation to social environment (Batty & Taylor, 2006; Gao & Maurer, 2009; Thomas et al., 2007).

EFE is related to emotional processing and to social cognition, assisting more complex processes such as Theory of Mind (ToM) (Adolphs, 2001; Mercer, 2013). Thereby, it is understood that through adequate EFE recognition it is possible to infer the felt emotion (Gao & Maurer, 2009) and make predictions about other's action (Sze et al., 2012), therefore adjusting respondent behavior (Gosselin & Pelissier, 1996). This ability is crucial since birth, given that children receive emotional stimuli but are less able to verbally express (Widen & Russell, 2008). Throughout childhood children start social experiences in complex environments where exchange of information is deemed necessary (Cheal & Rutherford, 2011) and therefore the developmental component of facial expression continues to play a key role on individual maturation.

Despite its importance throughout development, EFE recognition follows a slow developmental pathway (Batty & Taylor, 2006; De Sonneville et al., 2002; Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007; Gao & Maurer, 2010; Widen & Russell, 2008) depending on social learning and perceptual processes such as categorization and automation to fully develop (Pollak, Messner, Kistler, & Cohn, 2009). Furthermore, memory and attention improvement (Dennis, Malone, & Chen, 2009; Hills, 2012) as well as maturation of cerebral areas – including fusiform gyrus, prefrontal cortex, insula and amygdala (Adolphs, 2002; Thomas et al., 2007) are involved on emotional faces processing.

In addition, studies demonstrate that factors such as sex and age may influence EFE recognition skill (McClure, 2000; Rhodes & Anastasi, 2012). Data indicate a female advantage on face processing and EFE recognition (McClure, 2000; Rehnman & Herlitz, 2007). An own-sex-bias is also suggested (Wright & Sladden, 2003). Researchers, however, still aim to understand how basic emotions recognition develop through each age. Data indicate that happiness (in all intensities) is the first emotion to be recognized at approximately six year old (Gao & Maurer, 2009, 2010; Herba et al., 2008; Richards, French, Nash, Hadwin, & Donnelly, 2007). Anger is the second more easily recognized emotion – since seven years old -, but with intensity variations (Kessels, Montagne, Hendriks, Perrett, &

Haan, 2013; Richards et al., 2007). Sadness shows a similar development, with good levels of accuracy at ten years old (Durand et al., 2007; Gao & Maurer, 2009, 2010; Herba et al., 2008; Naruse et al., 2013). Fear and disgust have more mixed results, with most studies suggesting that good levels of accuracy are achieved by 10 years old (Durand et al., 2007; Herba et al., 2008; Mancini, Agnoli, Baldaro, Bitti, & Surcinelli, 2013). Surprise is considered a confounding factor due to its similarities with fear and, therefore, is often either not presented or arising debate about its results (Gao & Maurer, 2010; Kessels et al., 2013; Naruse et al., 2013). In this sense, development of EFE recognition seems to follow childhood chronological course. At six years old, there is a lower recognition ability, while at age 11, children present enhanced skills, considering their advanced neural maturation and socialization stages (Durand et al., 2007; Herba et al., 2008; Naruse et al., 2013).

Nevertheless, data already published present inconsistent results. Due to the scarce number of studies focused on the development of emotional facial expressions recognition its still not possible to generalize results and establish developmental markers. Moreover, stimuli duration and experimental method are varied, making results comparison more difficult. Beyond that, few studies assesses all six basic emotions and neutrality (Batty & Taylor, 2006); and the great majority uses only prototypical expressions (Batty, Meaux, Wittemeyer, Rogé, & Taylor, 2011; Chen, Schmitz, Domes, Tuschen-Caffier, & Heinrichs, 2014) and adult image sets which may compromise some results. Thus, despite the noticeable relevance of EFE recognition in interpersonal relationships, including childhood period, studies conducted with healthy children and seeking for biases in EFE recognition are scarce (Cassia, Pisacane, & Gava, 2012; Ebner et al., 2013; Scherf & Scott, 2012).

1.2. Present Dissertation

This dissertation was designed taking into account that (I) there is not yet available a photo set containing images from children younger than 10 years-old expressing the six basic emotions and (II) it is not yet possible to determine developmental markers of recognition of emotional faces.

The dissertation is composed of two studies. The first study entitled “Child Emotions Picture Set (CEPS) – Development of a database of children’s emotional expression”, was developed in order to have a complete database that could allow Study II as well as further studies on the topic. For this, 18 children posed or naturally expressed the basic emotions in three different intensities and a panel of expert judges rated each picture. The set is split into three age groups (6-7 years-old; 8-9 years-old; 10-11 years-old) of boys and girls. The final

version of CEPS consists of 225 photos of 17 children, boys and girls, aged six to 11 years-old from multiracial backgrounds posing or naturally expressing the six basic emotions – happiness, fear, disgust, surprise, sadness and fear – in three intensities – low, medium and high – and neutrality.

Study II, "Emotional Face Expressions Recognition in Childhood: developmental markers, age effect and gender effect", reports an empirical investigation of developmental markers of recognition of emotional faces in children between six and 11 years-old and the effect of sex, age and length of presentation on it. We hypothesized that (1) children by 10-11 years old present higher accuracy than children by 8-9 years old and children by 6-7 years old have the lowest accuracy results; (2) higher intensities are recognized earlier and easier; (3) girls present better results than boys; (4) emotions are better recognized at 1000ms of exposure; and (5) happiness is the first emotion to be identified by all ages, followed in sequence by anger, sadness, fear, disgust and surprise. An experiment based on CEPS was presented to 90 children divided in three age groups (6-7 years-old; 8-9 years-old; 10-11 years-old) of boys and girls. Happiness had the higher means of accuracy followed in sequence by disgust, surprise, anger, fear and sadness. Development of emotional face expressions recognition denote to follow childhood chronological course, although, results demonstrate a non-existence of a female advantage. Studies I and II are presented in full version in Chapters 2 and 3, respectively.

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Chapter 2

Database Development

This chapter presents one paper that dealt with the development of a photo database for EFE recognition assessment. This work was carried out because after reviewing the theme it was not found an available photo set containing images from children from six years-old expressing the six basic emotions. Therefore, study 1 describes the construction of Child Emotions Pictures Set (CEPS) – a database consisting emotional faces of boys and girls aged between six and 11 years-old expressing the six basic emotions.

2.1. CHILD EMOTIONS PICTURE SET (CEPS) – DEVELOPMENT OF A DATABASE OF CHILDREN'S EMOTIONAL EXPRESSIONS

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Abstract

Emotions are fundamental across human development. Recognition of facial expressions plays an important role in establishing social interactions through non-verbal communication. This is particularly true during childhood, as language skills are not yet fully developed. Nevertheless, few studies focus on face processing in children and most of the work uses adult face stimuli, since stimuli sets with children pictures are rare. The current study aimed to fill this gap through the development of the Child Emotions Pictures Set (CEPS). The database consists of emotional faces of 17 children who posed or naturally expressed the basic emotions. A panel of expert judges rated each picture. The set is split into three age groups (6-7 years-old; 8-9 years-old; 10-11 years-old) and overall includes 225 photos of boys and girls displaying happy, sad, angry, fearful, disgust and surprise expressions in three different intensities (high, medium and weak) plus a neutral picture. This work contributes for the scientific field by conducting a construction of a child face stimuli set, which is intended to further research on emotion processing in children. Additionally, the database will allow future studies on processing of facial expressions across childhood and on the effects of psychopathology.and pediatrics.

Keywords: face recognition, emotional processing, children, face stimuli set, database.

The recognition of emotional faces is a core sociability function as it facilitates interpersonal relationships through non-verbal communication (Batty & Taylor, 2006). Since the publication of Darwin's book: "The Expression of the Emotions in Man and Animals" in which the role of accurate recognition of emotions was highlighted as a key factor for the evolution and survival (Darwin, 1872), a number of studies have investigated emotional face processing on healthy and clinical samples (e.g. autism and schizophrenia) (Ekman et al., 1987; Kessels, Montagne, Hendriks, Perrett, & de Haan, 2014; Sachse et al., 2014). Such empirical studies claim that accuracy on emotional face processing is associated to global social and psychological well-being (Benuzzi et al., 2014; Sachse et al., 2014). As emotional face processing has been considered important for social life, changes in its functioning have been established as a marker for disruptive psychiatric symptoms across the development (Allott et al., 2014; van Rijn et al., 2011). However, as recently highlighted in a meta-analytic review (Rhodes & Anastasi, 2012), few studies have focused on face processing during childhood (Widen & Russell, 2008; Widen & Russell, 2013), probably due to the lack of data

sets of children stimuli. So, the aim of this study was to develop a database of emotional faces of Brazilian boys and girls aged 6-11 years-old expressing the six basic emotions and neutrality – the Child Emotions Pictures Set (CEPS).

A body of evidence demonstrates that facial emotion recognition is present since early childhood and that it evolves over the years (Farroni, Menon, Rigato, & Johnson, 2007), along with brain maturation (Batty, Meaux, Wittemeyer, Rogé, & Taylor, 2011; Batty & Taylor, 2006) and experience accumulation (Wright & Sladden, 2003). In this vein, Ekman and colleagues (1987) indicated that affective expressing (and recognition) is universal. However, recent reports questioned the universality of expression components due to cultural differences (Jack, Garrod, Yu, Caldara, & Schyns, 2012). Moreover, there are recognized biasing effects regarding emotional face processing, including own-sex bias (McClure, 2000; Wright & Sladden, 2003) and own-culture/race (Tuminello & Davidson, 2011). That is, emotional face processing is more accurate when people are processing in-group information. In this line, there is suggestive evidence that children would have an own-age bias (Rhodes & Anastasi, 2012). Theories assume an experience-dependent learning, suggesting that because recent social interactions people would develop more relevant personal and social schemas for own-age emotional face processing in order to cope better with their more recent and significant peer relationships (He, Ebner, & Johnson, 2011; Rhodes & Anastasi, 2012). Because language skills are not yet fully developed in childhood and the first interactions with peers are only beginning at this stage of life, non-verbal abilities, including facial emotion recognition, are essential tools for social interactions (Cheal & Rutherford, 2011).

Biasing effects have been flagged in literature of emotional face processing as a major concern in research that use samples from children (Rhodes & Anastasi, 2012). Stimuli data sets used for facial emotion recognition tasks are often criticized for using only pictures of adults when assessing children. Other issues indicated as limitations are the exclusive use of posed pictures and the disregard of cultural differences. Among the differences between spontaneously delivered and posed expressions, the former are more symmetric and involve more muscles in the region surrounding the eyes. Moreover, in everyday life people are often required to recognize spontaneous emotional face expressions rather than the posed ones (Ekman & O'Sullivan, 1991). Additionally, regarding intensity of expressions it should be stressed that when a person is asked to pose a facial expression, such expression will hardly ever be of low or medium intensity. That is, pictures of posed expressions commonly show extremely intense emotional expressions.

On the other hand, spontaneous expressions vary in intensity, just like people vary in their inherent ability to express emotional intensity in their everyday lives. (Elfenbein & Ambady, 2002; Motley & Camden, 1988). Moreover, studies on facial emotion recognition might consider different emotion intensities since subtle differences can be found in less intense expressions, but not in the prototypical ones (Elfenbein & Ambady, 2002). Thus, although the pictures of posed expressions were useful to measure emotion facial recognition, spontaneous stimuli have more construct and ecological validity (Motley & Camden, 1988; Russell, 1994).

Facial emotion recognition data sets

Given that a number of researchers assume that facial emotion recognition has a cross-cultural homogeneity, some studies applied experimental tasks consisting of photographs of actors or non-professional people portraying facial expressions (Batty et al., 2011; Deeley et al., 2008). However, results related to those biasing effects and limitations in the quality of pictures led to an upgrade of methodological techniques, and standardized sets of emotional faces were developed, such as the Pictures of Facial Affect (PFA) (Ekman, 1976), which is the most widely used database in experiments. PFA is composed of 110 black-and-white photographs of five male and six female Caucasian professional actors displaying spontaneous images of six basic emotions (happiness, sadness, anger, fear, disgust and surprise) on high intensity, plus a neutral face (Ekman, 1976). Subsequently, Matsumoto and Ekman aimed to fill the ethnic gap in databases by developing the Japanese and Caucasian Facial Expressions of Emotion (JACFEE) and Neutral Faces (JACNeuF) (1988). This database comprises 56 photos of two men and two women of either Japanese or Caucasian descent.

PFA has brought huge contributions to the face processing field; nevertheless, in order to ensure a higher quality set of stimuli with a greater amount of pictures, the Facial Action Coding System (FACS) was developed (Ekman & Friesen, 1978). The FACS has a coding system that maps the muscular activities that produce changes in facial expression and combines them to determine which emotion is being expressed. This system has been recently updated (Ekman, Friesen, & Hager, 2002) and other high quality stimuli data sets for facial emotion recognition tasks have been developed, such as the Karolinska Directed Emotional Faces (KDEF) (Calvo & Lundqvist, 2008) and the NimStim set of facial expressions (Tottenham et al., 2009). Meanwhile, Gur and colleagues (2002) attempted a different proposal of the standard databases by collecting 3D color photographs (posed and evoked) in

a sample of 139 actors of both sexes (aged 10-85 years old), and a vast ethnic background (91 Caucasian, 32 African American, six Asian and ten Hispanic), expressing the six basic emotions plus neutrality under three levels of intensity (low, medium and high).

Children facial emotion recognition data sets. Despite the striking relevance of stimuli sets of children faces, to the best of our knowledge there are few stimuli sets of children images and not all of them are openly available. Among the recognized stimuli sets of children faces we highlight the National Institute of Mental Health Child Emotional Faces Picture Set (NIMH-ChEFS) (Egger et al., 2011) which comprises 482 high resolution and color pictures of child actors aged 10-17 years old. The children posed displaying fear, angry, happy, sad and neutral facial expressions in two eye gaze conditions – direct and averted gaze conditions. However, this database is composed mostly by adolescents who do not express disgust and surprise. So, this set is incomplete for studies of emotion and face processing in children. Other known stimuli set of children faces is the recently published Dartmouth Database of Children's Faces (DDCF; Dalrymple, Gomez, & Duchaine, 2013) which includes a large data set of photographs of 40 male and 40 female children aged 6-16 years old who posed eight expressions (in addition to the six basic emotions they posed for contempt and neutral expressions). Moreover, there are other stimuli data sets of child faces (e.g. "Reconnaissance des Emotions Faciales pour Enfants (TREFE)" (Golouboff et al., 2008) already cited in previous studies, but they are not available for using and have been used only for the research groups that developed the data sets.

This study aimed to fill the gap of facial emotion recognition research by developing the CEPS – a set of stimuli consisting of both posed and spontaneous emotional faces of boys and girls aged 6-11 years-old. an age range from 6 to 11 years old was determined for two reasons: firstly, the interest in studying school age children that are starting to apply their cognitive skills to develop and maintain solid peer relationships and secondly because we expected the children to be literate in order to fully understand facial emotion recognition. The CEPS was designed to include pictures of the six basic emotions (happy, sad, angry, disgust, fear and surprise) on three different intensities (low, medium and high) plus neutrality.

Methods

This work is in line with previous studies that described procedures assumed as gold-standards for the construction of a database of emotional face expressions (Tottenham et al., 2009). Therefore, three steps were followed: (1) image acquisition, (2) selection of photographs and (3) expert rating of the pictures.

Image Acquisition

Participants. Participants were contacted using a snowball method through indication of associated researchers. Photos were collected from 18 participants (9 boys/9girls) split into three groups: six-seven years-old (n=6), eight-nine years-old (n=6), and 10-11 years-old (n=6) – age groups were determined based on inclusion criteria for school grades in Brazil given that it is more likely for children to interact with same grade peers.

Based on facial features, 77.78% (n=14) of the children were Caucasian, 16.67% (n=3) were Afro-American and 5.56% (n=1) were indigenous. The study was approved by the Ethics Research Committee of the Pontifícal Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil. All participants and guardians gave written informed consent before image acquisition.

Procedures and Stimuli. We conducted procedures to take spontaneous and posed pictures. All procedures started with spontaneous pictures. Participants were seated approximately 60cm from a 14.7-in. monitor Dell Inspiron computer. A Sony Handycam AVCHD was used to record images. Natural expressions were obtained while participants watched short scenes of series or movies of public domain available on YouTube, which were presented on Microsoft Windows Media Player. Considering the absence of validated emotion induction video base in Brazil, the selection of the videos was carried out by a panel of health professionals with expertise in child development. The selected videos were as follows: a) *Happiness:* Scene of the series “Chaves” in which characters are having an arithmetic class and funny situations occur. b) *Fear:* Scene of the movie Paranormal Activity in which two children are in the bedroom and objects start to move. In the end, to neutralize negative emotions a dog playing with a blanket appears suggesting the dog caused the objects to start moving. c) *Disgust:*A cook dirties the food to be served in the restaurant. d) *Surprise:* a video with images of optical illusion without sound. Subtly, the screen turns black and there is a loud sound of a scream, followed by a screen with the words "Congratulations! You have won

a prize!" e) *Anger and sadness:* Participants were asked to think about and ideate a special experience that has aroused the stated emotion in their past life. f) *Neutral:* A documentary about plants. Anger and sadness were initially planned to be induced by videos, but the first two participants refused to watch these videos and the third did not show expressions. Therefore, for ethical reasons, we did not use videos that could elicit more anger and sadness. However, following Coan and Allen (2007) for these expressions we used a secondary well-known method for emotion elicitation – requiring participants to think about situations of their life.

Spontaneous emotion induction has a limitation *per* se as emotions are by and large subjective. In order to minimize this limitation after the presentation of stimuli, participants were asked to indicate which expression they felt (i.e. "What did you feel?"). Then the participants were asked to pose the very same expression (i.e. could you do the face of this feeling?). To produce the facial expression of different intensities, we used as examples the stimuli taken from Gao and Maurer (2010) of NimStim (Tottenham et al., 2009). Children were shown pictures of different intensities and asked to mimic each intensity. After pictures of posed expressions were taken, children were asked to say if they agreed that their face represented the emotion they intended to display. At the end of this process, a neutral scene was shown to defuse emotions (Figure 1).

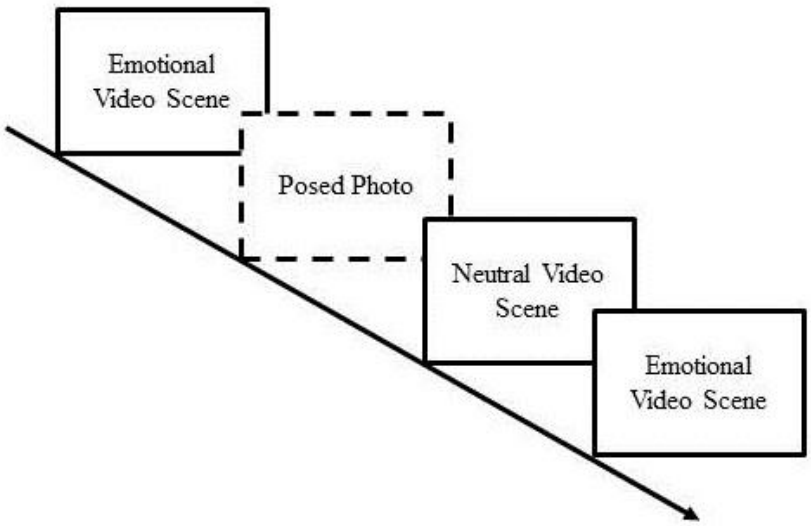


Figure 1. Stimuli order

Imaging selection and processing

Initially, the best frames representing the target expressions of both natural and posed emotions were selected based on (1) child agreement that her/his face depicted the target emotion; (2) direction of the eyes at the moment the picture is taken; and (3) subjective sharpness and contrast (or gamma) assessments were done in order to select the best pictures for editing. In the selected pictures, children should be looking at the camera or close to it. All images of the children looking at a different point or whose eyes were not focused on the camera were discarded. Frames that children reported to express an emotion other than target emotion were excluded. After selection, the pictures were turned to black and white. The selected pictures were edited in a 300X300 pixels dimension (100 dpi). An example of picture after edition is shown in figure 2.

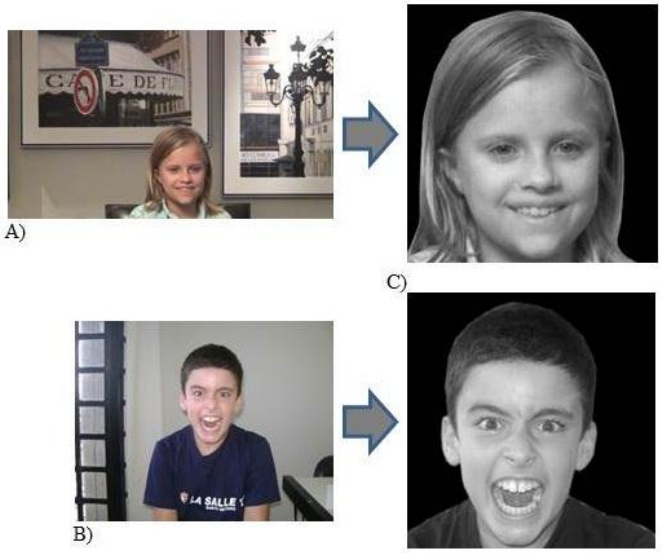


Figure 2. Photo edition

Note: A) Natural expression.; B) Posed expression.; C) Edited photos.

Expert rating

In order to select stimuli for the final database, 30 psychologists with experience in child development and certification in Ekman SETT 3.0 software (minimum accuracy achievement 80%) labeled the photos. The Ekman SETT 3.0 software is the only online software available for this purpose and is gold-standard. The raters were divided into six groups of five judges and the database was split into five versions of 50 pictures and one version of 23 pictures. Each group of raters received one of the database versions. Pictures were shown on the online survey software SurveyMonkey and raters were asked to label each picture emotion and intensity using a forced-choice method (Figure 3). After the expert

ratings, pictures with ≥ 60% of agreement for both emotion and intensity were considered eligible for inclusion in the dataset.

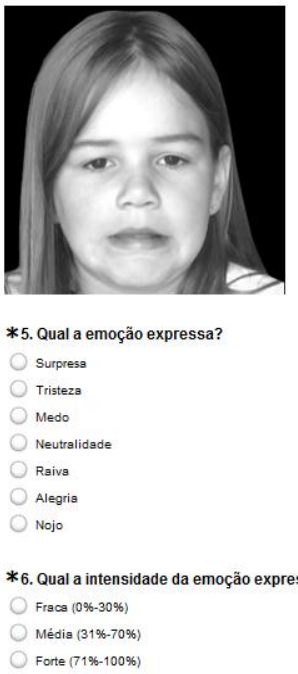


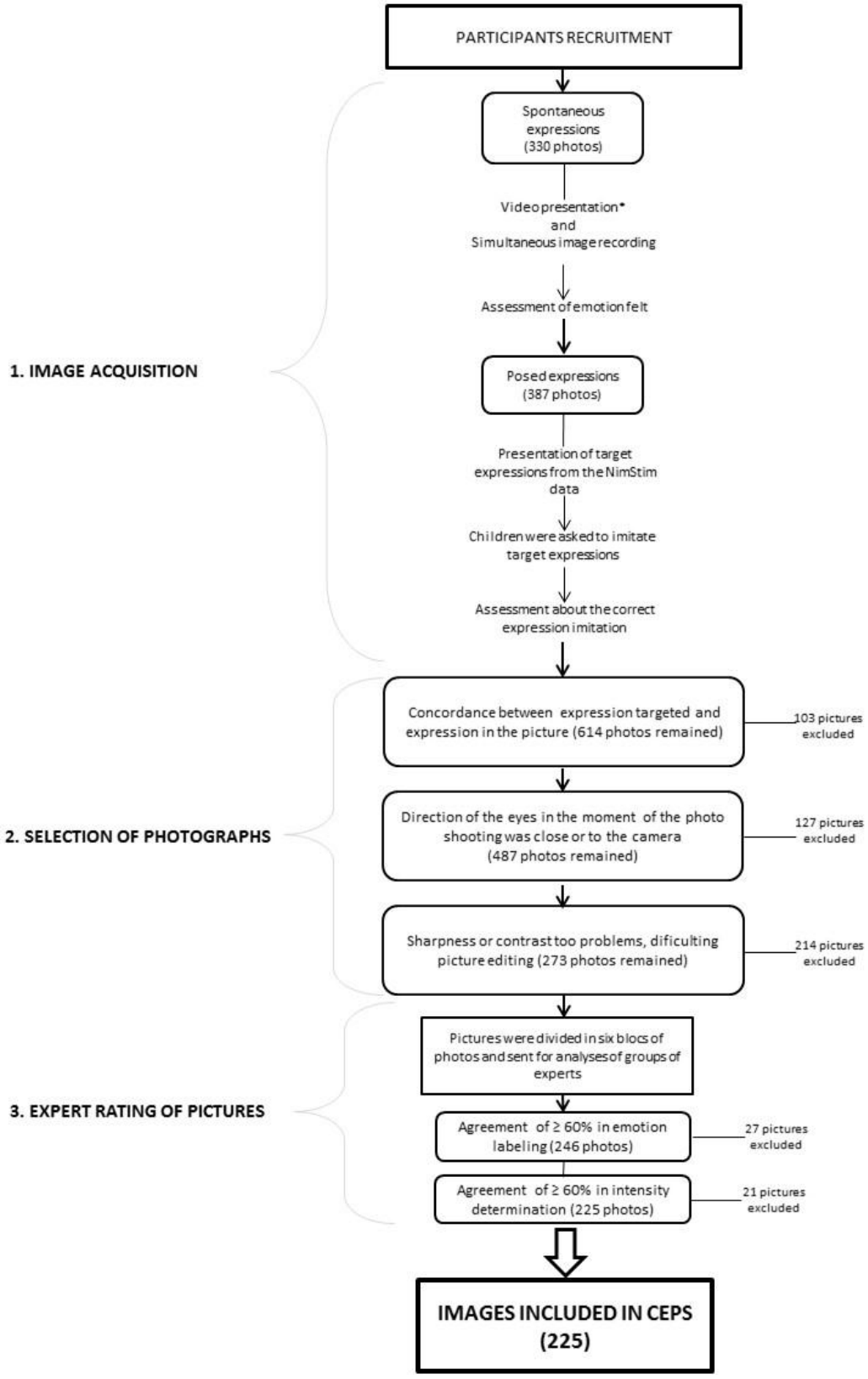
Figure 3. Pictures rated

Data Analysis

Initially, the´ ratings of the judges for all pictures included in the dataset were computed. Images with less than 60% agreement were excluded. Next, descriptive statistics (child age, child sex emotion and intensity, whether the depicted emotion was spontaneous or posed) and reliability coefficient of the retained frames were computed. We calculated kappa inter-raters agreement considering the raters division into six groups. Then we investigated the effect of spontaneous vs. posed pictures on raters´ agreement and compared the proportion of spontaneous vs. posed pictures included in the final dataset using chi-square.

Results

A flowchart of the methodological steps followed is presented in Figure 4.



Note: Sadness and anger were induced by a different method

Figure 4. Flowchart of methodological steps

Image acquisition

At the end of image acquisition procedures, a total of 717 pictures were obtained (330 spontaneous and 387 posed). One participant was excluded because he refused to take pictures, although he had previously agreed to participate in the study. Spontaneous pictures of angry faces were more difficult to obtain than images of all other emotions. Of all the initial pictures, 444 were excluded: 103 because the emotions the children felt or posed were different from the one that was targeted; 127 because the child was not looking at the camera; and 214 because image quality was poor. Considering the total number of photos initially taken, the final images selected for edition (273) included significantly more posed pictures than spontaneous pictures, 163 vs. 110, respectively ($x^2(2)$ 5.83, p = 0.015). The inclusion of more photos of posed expressions was expected since spontaneous pictures were obtained through video presentations, and, thus, the children were probably moving their heads when expressing the emotions or looking at a different direction than the camera (i.e., to the screen where the videos were displayed). Moreover, posed expressions should not be compared to the emotions the children were feeling when the picture was been taken, reducing the number of those excluded.

Experts ratings

The percentage of raters judging each of the seven emotions of the three intensity categories for each photograph was calculated. Of the 273 pictures rated, 48 photos were excluded because the percentages of agreement were lower than 60%. Twenty-seven (27) pictures mismatched for emotional labeling (e.g. judges attributed a different= emotion of that initially intended) and 21 pictures mismatched for intensity determination and were excluded. Of the excluded pictures, 20 were spontaneous and 28 were posed, revealing that raters showed more agreement on emotion labeling and intensity determination for spontaneous expressions than for posed expressions, but the difference in this proportion was not statistically significant (x^2 (2) 0.045, p = 0.83). No significant differences in sex, age or ethnicity were found between retained and excluded pictures. Agreement between raters ranged between good (k= .60) and excellent (k=.91) (Fleiss, Levin, & Paik, 2003).

The final version of the dataset consists of 225 pictures from eight boys and nine girls (total n=17) posing the six emotions on three intensities and neutrality (see Table 1). Out of the 225 pictures, 40% (90 pictures) were naturally expressed and 60% (135 pictures) were posed.

Table 1. Total number of photo per category

Emotion	Intensity	Boys	Girls
	Low	3	3
Angry	Medium	3	3
	High	10	8
	Low	1	2
Disgust	Medium	9	6
	High	3	10
	Low	1	1
Fear	Medium	8	5
	High	3	2
	Low	8	8
Happy	Medium	7	15
	High	11	7
	Low	7	2
Sad	Medium	5	8
	High	6	5
	Low	2	2
Surprise	Medium	5	6
	High	6	10
Neutral		9	15

The average agreement between judges was 85.06%; most of the pictures obtained over 100% of agreement. Table 2 shows agreement rates for pictures considering each emotion and intensities. Examples of pictures for each emotion and intensity are shown in Figure 5.

Table 2. Description of the agreement of pictures

Emotion	Intensity	Average agreement (%)	Number of naturally expressed	Number of evoked pictures
	Low	73,33	1	5
Angry	Medium	93,33	1	5
	High	91,11	1	17
	Low	73,33	1	2
Disgust	Medium	86,67	5	10
	High	78,46	5	8
	Low	60,00	1	1
Fear	Medium	75,38	5	8
	High	76,00	0	5
	Low	91,25	11	5
Happy	Medium	96,36	10	12
	High	100,00	10	8
	Low	71,11	4	5
Sad	Medium	81,53	6	7
	High	85,45	7	4
	Low	80.00	3	1
Surprise	Medium	81,81	5	6
	High	81,25	3	13
Neutral		79,17	10	14

Note: From the left top: low happiness; medium happiness; high happiness; low fear; medium fear; high fear; low disgust; medium disgust; high disgust; low anger; medium anger; high anger; neutrality; low surprise; medium surprise; high surprise; low sadness; medium sadness; high sadness.

Figure 5. Examples of CEPS images

Discussion

The main objective of this article was to present the development of the Child Emotions Pictures Set (CEPS) – a dataset of facial expression stimuli of children aged 6-11 years old. This was done by acquiring images from facial expressions of children and determining the appropriate emotion label and intensity. The work included imaging acquisition, imaging selection and editing and an evaluation by a panel of experts. The final version of CEPS consists of 225 photos of 17 children, boys and girls, aged 6-11 years old from multiracial backgrounds posing or naturally expressing the six basic emotions – happiness, fear, disgust, surprise, sadness and fear – in three intensities – low, medium and high – and neutrality. In addition, the dataset development was done in accordance with previous datasets of emotional face pictures development, including pictures of different sexes, ethnicities and both spontaneous and posed pictures with different intensities. The CEPS provides a contribution to the scientific community by making available a dataset of emotional face pictures of children, which has been a major concern in neuroscientific research. The dataset is available at no cost for the scientific community upon request to the authors.

Developmental and psychiatric research has recently focused on different psychological abilities involved in processing social information, including facial emotion recognition and theory of mind (the ability to interpret others' mental states, thoughts, beliefs, intentions, etc.) (Adolphs, 2009). The interest in investigating such abilities at early developmental stages arise from theories and preliminary evidence indicating that impairment in understanding social – particularly emotional – information would lead to reduced well-being, inability to maintain good relationships and vulnerability to mental disorders (Adolphs, 1999, 2009; Arsalidou, Morris, & Taylor, 2011; Baron-Cohen, Leslie, & Frith, 1985; Frith & Frith, 2012; Martins, Sanvicente-Vieira, Grassi-Oliveira, & Brietzke, 2011). However, the assessment of such abilities for a long time has been a matter of concern for researchers (Calvo & Lundqvist, 2008; Egger et al., 2011; Gur et al., 2002; Harrington, Siegert, & McClure, 2005; Martins et al., 2011). Particularly regarding emotional face processing, there is a lack of datasets for investigating the topic, which was flagged by the NIMH previously (Egger et al., 2011). Moreover, despite the availability of datasets of child emotion face pictures, there are still some limitations that deserve attention, e.g. exclusive inclusion of posed pictures, lack of multiracial pictures, absence of reliability or validity assessment, and unavailability of the dataset for free.

The CEPS is composed by posed and naturally expressed photos, contrasting with most databases that use mainly professional actors posing the expressions (Calvo & Lundqvist, 2008; Ekman, 1976; Tottenham et al., 2009). There are indications that spontaneous and posed expressions are different (Ekman & Friesen, 1975; Ekman & O'Sullivan, 1991) and although it is possible to correctly label an emotion on a picture of a posed expression, raters are more likely to judge a posed expression as fake, masked or a suppressed emotional experience, which can make facial emotion recognition difficult (McLellan, Wilcke, Johnston, Watts, & Miles, 2012). In accordance with assumptions about differences regarding spontaneous and posed expressions, we developed the CEPS to include both posed and spontaneous pictures. Moreover, the CEPS was designed to be used in different emotional processing studies. Therefore, by including posed and spontaneous pictures we allow researchers to investigate the detection of genuine or fake expressions, for example.

The images selected for inclusion in the CEPS were rated by trained raters using the SETT 3.0, a standard software for the training of facial emotion recognition (Ekman & Friesen, 1978). We required raters to achieve a minimum 80% score at SETT 3.0 in order to provide uniformity among raters. Moreover, we calculated Kappa inter-rater coefficients whose values supported high concordance among judges. Results from Kappa inter-rater coefficients indicate that indeed there was a highly agreement among experts. The ratings were also coherently subject of some moderation because the emotions were different.

Some limitations of our study must be highlighted. First, some pictures were excluded. The children who participated in image acquisition were not actors; some of them affirmed they could not do everything that was expected from them, e.g. wrinkling of nose and raising and straightening the eyebrows. Nevertheless, some studies indicate that this ability has been recently developed with subjects before adolescence, and they were found to satisfactorily mimic emotions (Gosselin & Larocque, 2000). Moreover emotion processing evolves through the development and in early ages it is expected difficulties in correctly labeling emotions (Denham et al., 2012). After each picture was taken, we asked the children to say which emotion they felt or posed. If the emotion referred by the child was not the target emotion, the picture was excluded. Several photos also were excluded because children were not looking at the camera. Thus, despite the use of a different methodology, it is worthy to note that studies using functional magnetic resonance imaging (fMRI) often refer motion problems when working with children (Yerys et al., 2009). Second, there are some problems associated to the induction of emotions. We could not be sure if the target emotion was actually the

induced emotion. As already stated, we kept questioning which emotion each child was feeling/mimicking in order to minimize this problem. Additionally, we could not use the same emotion induction method for all emotions. Because participants might refuse to watch videos displaying contents of anger and sadness or not display face reactions to those for ethical reasons, we chose a second well-known method for inducing emotions, consisting in asking the child to think about a situation related to the emotion.

Another limitation is subjectivity. Authors and experienced study collaborators were required to suggest videos. The results supported the partial efficacy of the videos selected, since several, though not all, spontaneous faces were obtained. A third limitation is that all participants were originally from southern Brazil, which did not allow inclusion of a variety of facial features, in particular amongst the Caucasian participants. In-group biasing effects have been reported related to culture, which can also be a limitation. Nevertheless, on a positive perspective we managed to develop a dataset of a particular cultural group. Regarding the expert ratings, the compulsory choice design may have biased raters choice, since the evaluation did not include the option "photos judged as not fitting any of the seven targeted emotions". Developers of other sets included options as "none of the above" (Tottenham et al., 2009), or variables as "Agreement/Disagreement rate" and "Representativeness" (Egger et al., 2011).

Despite its limitations, the present study has a number of contributions and strengths. It provides a complete set of reliable images of six basic emotions in three intensities spontaneously delivered and posed by children. The CEPS contributes for the scientific field by making available a child face stimuli set, which is intended to be used in further research on emotion processing in children. CEPS copes with a number of limitations found in previous datasets, for example it contains pictures from spontaneous and posed emotional expressions, at different intensities and the participants are from regions not commonly used in datasets – southern Brazil. The process used in the development of this database can be used in future research in developmental studies – including neuropsychology, psychiatry and pediatrics, in Brazil – and enables the development of cross-cultural studies in the field. Such investigations are of great interest for determining differences in social and emotional development and the identification of early signs of disruptive symptoms.

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Chapter 3

3. EMOTIONAL FACE EXPRESSIONS RECOGNITION IN CHILDHOOD: DEVELOPMENTAL MARKERS, AGE EFFECT AND GENDER EFFECT

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Abstract

Background: Recognizing emotional face expressions in others is a valuable strategy of non-verbal communication and is particularly relevant throughout childhood given that language skills are not yet fully developed and the first interactions with peers have just started. Despite this, studies on area are scarce. This study aim to fill this gap investigating developmental markers of recognition of emotional faces in children aged between six and 11 years-old and the effect of age, sex and length of presentation on it. **Methods:** A total of 90 children split into three age groups: 6-7 years-old (n=30); 8-9 years-old (n=30); 10-11 years old (n=30) participated. Participants were exposed to 38 photos of children expressing happiness, sadness, anger, disgust, fear and surprise on three intensities and neutrality presented in two lengths (500ms and 1000ms). **Results:** Happiness were the easiest expression to be recognized followed in sequence by disgust, surprise, anger, fear and sadness. 10-11 years-old group showed the highest accuracy means and 6-7 years-old group had the lowest means of accuracy. There is no female advantage and length of presentation does not show significant differences. **Conclusion:** Happiness is the first emotion to be recognized,followed by crucial emotions for survival and surprise and, lastly, sadness. This development also follows chronological course. Data support a non-existence of female advantage or a significant difference between lengths of presentation.

Key words: face recognition; emotion; development; children

Face expressions are well recognized as a valuable strategy of non-verbal communication through lifespan. Recognizing emotional face expressions in others is a core ability for an adaptive social life (Batty & Taylor, 2006). This ability is particularly relevant throughout childhood given that language skills are not yet fully developed and the first interactions with peers have just started (Cheal & Rutherford, 2011). Despite the important role that facial expression play on individual maturation, studies conducted with healthy children and seeking for biases in emotional face expressions recognition are scarce, and it is not yet possible to determine developmental markers of recognition of emotional faces (Cassia, Pisacane, & Gava, 2012; Ebner et al., 2013; Scherf & Scott, 2012). Thereby, the goal of the current study was to determine developmental markers of recognition of emotional faces in children aged between six and 11 years-old.

Previous research has shown that emotional face expressions recognition follows a slow developmental pathway (Batty & Taylor, 2006; De Sonneville et al., 2002; Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007; Gao & Maurer, 2010; Widen & Russell, 2008). This enhancement relies on social learning and maturation or improvement of fundamental processes such as perceptual processes (categorization and automation), memory, attention and cerebral areas – fusiform gyrus, prefrontal cortex, insula and amygdala – involved on emotional faces processing (Adolphs, 2002; Dennis, Malone, & Chen, 2009; Hills, 2012; Pollak, Messner, Kistler, & Cohn, 2009; Thomas, De Bellis, Graham, & LaBar, 2007).

Furthermore, studies suggested that factors such as sex and age may influence emotional face expressions recognition skill (McClure, 2000; Rhodes & Anastasi, 2012). Across all ages, females present an advantage on facial expression recognition. This female advantage is explained by three theories: (1) Neurobehavioral Maturation Model - sex differences in the development of emotional face expressions recognition are correlated with sex differences in maturation of neurological structures as amygdala and regions of the temporal cortex; (2) Social Constructivist Model of Facial Expression Recognition - sex differences in emotional face expressions recognition derive from different patterns that parents socialize their sons and daughters; (3) evolutionary hypothesis – female advantage is an evolved adaptation related to the care of preverbal offspring (see McClure, 2000 and Hampson, van Anders, & Mullin, 2006 for a review).

A meta-analysis by McClure (2000) reviewed 117 studies on sex differences in emotional face expressions recognition from infancy through adolescence. A smaller but statistically significant female advantage was found among children and adolescents. However, McClure highlights that many studies used small samples, thus, results may not accurately reflect the full population distribution. Also, a small number of studies provided effect sizes and only 50% of the available effect sizes were statistically significant allowing biased and overrepresented results of effect sizes (McClure, 2000). Nonetheless, other studies also indicate this female advantage – especially on negative emotions – (Rehnman & Herlitz, 2007; Williams et al., 2009) as well as an female but not male own-sex-bias (Wright & Sladden, 2003).

On the other hand, research has yet aimed to understand how basic emotions recognition develop through each age. Data indicate that by six years old children recognize happiness in all intensities (Gao & Maurer, 2009, 2010; Herba et al., 2008; Richards, French, Nash, Hadwin, & Donnelly, 2007). At seven years old it is possible to recognize anger faces

but with intensity variations (Kessels, Montagne, Hendriks, Perrett, & Haan, 2013; Richards et al., 2007). Sadness shows a similar development, with good levels of accuracy at 10 years old (Durand et al., 2007; Gao & Maurer, 2009, 2010; Herba et al., 2008; Naruse et al., 2013). Fear and disgust present mixed results with good levels of accuracy by 10 years old (Durand et al., 2007; Herba et al., 2008; Mancini, Agnoli, Baldaro, Bitti, & Surcinelli, 2013). Surprise is considered a confounding factor due to its similarities with fear being often not included on experiments or arising doubts about its results (Gao & Maurer, 2010; Kessels et al., 2013; Naruse et al., 2013). In this sense, development of emotional face expressions recognition seems to follow childhood chronological course. At six years old, there is a lower accuracy, while at age 11, children present enhanced skills (Durand et al., 2007; Herba et al., 2008; Naruse et al., 2013).

However, these findings are not consistent. Stimuli duration and experiments´ methods are varied, making results´ comparison more difficult. Beyond that, few studies assess all six basic emotions and neutrality (Batty & Taylor, 2006); and the great majority uses only prototypical expressions (Batty, Meaux, Wittemeyer, Rogé, & Taylor, 2011; Chen, Schmitz, Domes, Tuschen-Caffier, & Heinrichs, 2014) and adult image sets (Gao & Maurer, 2010; Kessels et al., 2013; Mancini et al., 2013; Naruse et al., 2013). In the current study, we investigated developmental markers of recognition of the six basic emotional faces presented in three intensities in children aged between six and 11 years-old and the effect of age, sex and length of presentation on this ability. We hypothesized that (1) children by 10-11 years old are better in identifying emotional faces (more accurate and better intensity attribution) than children aged 8-9 years old and children by 6-7 years old with the later having the worst performance scores; (2) pictures depicting faces of higher intensities are recognized at earlier ages and more accurately than pictures depicting emotions of low and medium intensity (3) girls outperform boys in emotion identification (accuracy of emotion and attributed intensity); (4) emotions are better recognized at 1000ms of exposure; and (5) happiness is the first emotion to be identified by all ages, followed in sequence by anger, sadness, fear, disgust and surprise.

Methods

Participants

Participants were recruited in four schools from two cities in southern Brazil. A total of 520 children were approached and parents gave informed consent for 136 children. Of this sample we excluded: a) 43 children who followed above the clinical threshold on the CBCL (total, internalizing and externalizing scores); b) Two children who showed inattention during procedure and c) One child from whom we could not recover experimental data. All children scored above the cognitive impairment threshold using the Raven´s Matrices. Thus, results reported in this paper concern 90 children (mean age=108,04 months, SD=18,76), 48,9% boys, 51,1% girls), split into three age groups: 6-7 years-old (n=30); 8-9 years-old (n=30); 10-11 years old (n=30) (see Table 1 for details). This study was approved by the Ethics Research Committee of Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil. All participants and guardians gave written informed consent.

Table 1. Sample Characteristics

	Age (months) (mean (SD))	Gender		School			Raven – Percentile score (mean (SD))
		Male (n)	Female (n)	State (%)	Private (%)	Grade (mean)	
6-7 years-old	86.10 (6.04)	14	16	33.33	66.66	1.63	71.10 (28.63)
8-9 years-old	108.80 (6.64)	15	15	26.66	73.33	3.27	78.50 (16.77)
10-11 years-old	129.23 (6.07)	15	15	26.66	73.33	4.93	63.00 (22.38)

Instruments

Child Behavior Check-List (CBCL). Inventory answered by parents about their children aged between six and 18 years old in order to identify behavioral and emotional aspects of children and possible psychopathological disorders. The inventory comprises 118 problem items that parents rate 0=not true, 1 – somewhat or sometimes true, or 2=very true or often true, based on the past 6 months. Eight syndromes, three broadband scales (Internalizing, Externalizing, and Total Problems), and six DSM-oriented scales are evaluated (Achenbach & Dumenci, 2001). CBCL was translated into Portuguese by Silvares, Rocha & Equipe Projeto Enurese in 2007, although this study was not published yet.

Raven's Progressive Matrices (Colored scale). Nonverbal test for assessment of level of intelligence of individuals between 5 and 11 years. Application is divided into a series of matrices or drawings with an introductory problem, whose solution is clear, providing a standard for the task, that becomes progressively difficult. Results are expressed in percentages and grades that varied from 1 to 5, with grade 1 indicating intellectually superior intelligence and grade 5 intellectually deficient intelligence. This instrument was adapted to Brazil by Angelini and colleagues in 1991 and revised in 1999 (Angelini, Alves, Custódio, Duarte, & Duarte, 1999). Standards for regional samples were reported by Bandeira (2004).

Emotional Face Expression Recognition Task. A total of 38 photos of 15 children (seven girls and eight boys) expressing happiness (six pictures), sadness (six pictures), angry (six pictures), disgust (six pictures), fear (six pictures) and surprise (six pictures) on three intensities (low, medium and high) and neutrality selected from CEPS (Romani-Sponchiado, Sanvicente-Vieira, Mottin, Hertzog-Fonini & Arteche, *manuscript in preparation*) were used on experiment. Images are in black and white colors and have a resolution of 300x300.

Procedures

Parents gave written informed consent and completed CBCL and a clinic interview of social and health information about the children. Participants were tested individually in a quiet and illuminated room at school, seated approximately 60cm of a 14.7-in. monitor Dell Inspiron computer. Using E-prime software, the 38 images were randomly shown to children with duration of 500ms and 1000ms. Each photo was subsequently classified according to emotion (sad, neutral, happy, angry, surprise, disgust and fear) and intensity (low, medium and high). In order to help younger children on emotion classification stage, schematic faces were shown with classifications (see Figure 1). A total of 78 trials composed the experiment (two training trials and 76 task trials). Following the experimental task, the Raven's Progressive Matrices were applied.

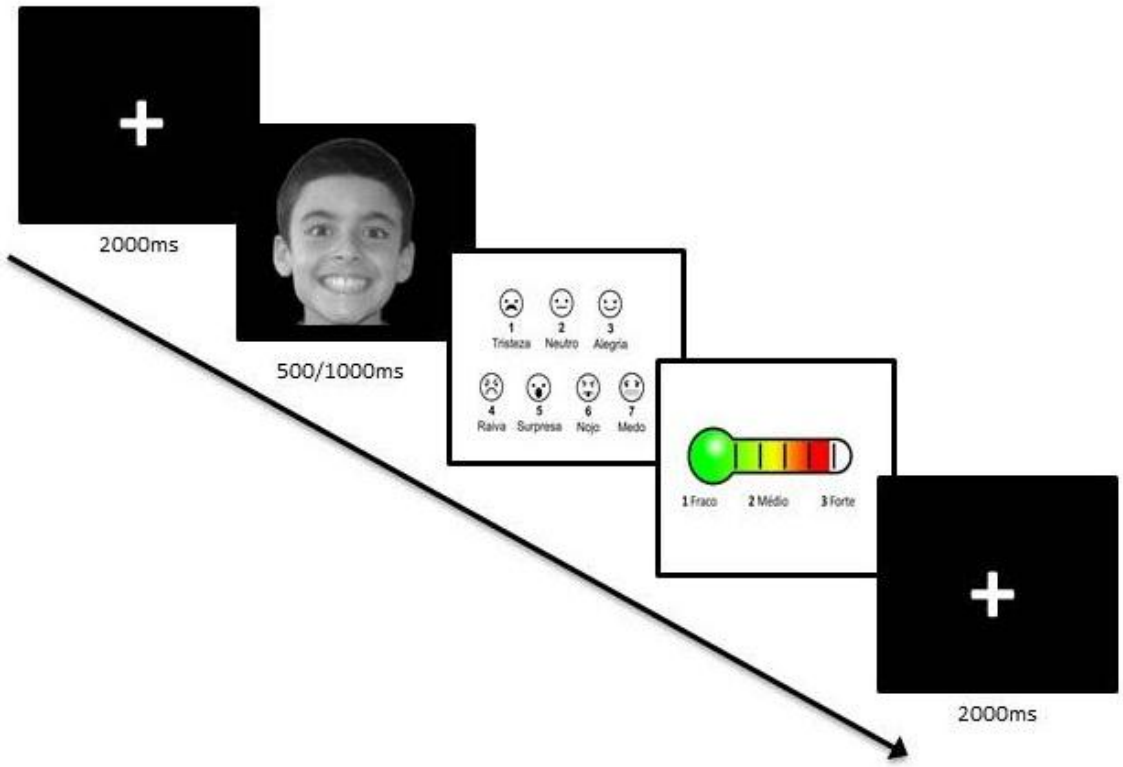

Figure 1. Flowchart of stimuli presentation

Data analysis

Participants were assigned 1-point for each correct identification of the face emotion (happy, sad, fear, disgust, anger, surprise). Accuracy score was a proportion computed by the sum of correct identifications of the target emotion divided by the number of trials of each emotion. This was computed for overall emotion (e.g. considering all valences) as well as for each emotion in each valence (e.g. high happiness, medium happiness, low happiness etc). Intensity analyses were conducted only on trials where the emotion was correctly identified. Here we considered for analyses the average intensity attributed by children to emotional faces of each valence. Low intensity faces were expected to have average scores close to 1, medium intensity close to 2 and high intensity close to 3. A series (for intensity and accuracy) of 2(Length of presentation)x3(age group)x2(sex) repeated measures analyzes were performed in order to investigate developmental makers in the processing of faces. Main effects of length of presentation, age and sex and interactions length of presentation by age, length of presentation by sex and age by sex are reported.

Results

Emotion accuracy

As seen in Table 2 the highest rates of accuracy were observed for happy faces followed by disgust and surprise emotions. The lowest rates of accuracy were observed for fear (38% 500ms and 36% 1000ms) and sad faces (29% 500ms and 32% 1000ms). By and large children´s performance got better as intensities got higher, although a platoon effect was observed with rates of accuracy not exceeding 87%. There was considerable variability across emotion valences in particular for sad, anger and surprise faces. For sad faces children showed a very poor performance (close to 20% correct identification) on low and medium intensities, nevertheless on high intensity their accuracy reached close to 50%. For anger faces their performance increased by almost a third from low to medium intensity, but a less steep increment in accuracy was observed from medium to high intensity. Finally surprise faces of low intensities were not accurately identified by almost none of the children (close to 0% correct identification), but at medium intensities their accuracy is above 65% and at high intensity over 80% of surprise faces are correctly identified.

Length of presentation effect

Length of presentation had no significant effect in accuracy scores in any of the target emotions (all *p´*s >.16), except for angry faces. Children were significantly more accurate when angry faces were presented at 1000ms (52% correct) than when the same stimuli was shown at 500ms (41% correct). When effects were investigated considering the face valence, findings yielded similar time of exposure effects for medium and high intensity angry faces, but there was no significant effect in low angry faces with participants having low rates of accuracy in both 500ms (28% correct) and 1000ms (31% correct).

Age effect

Age effects were investigated in each of the six emotions (happy, sad, fear, disgust, anger, surprise) and in all valences of each emotion (see Figure 2). Significant age effects were observed in overall happiness [$F(2, 84)=5.68$, $p=.005$, $\eta^2=.12$] with children aged 6-7 (67% accuracy) being less accurate than both children aged 8-9 (83%, $p=.008$) and 10-11 (85%, $p=.003$). The same pattern was observed for low intensity happiness [$F(2, 84)=6.17$, $p=.003$, $\eta^2=.13$] with younger children showing a poorer performance (51%) when compared

to 8-9 (72%, p=.01) and to 10-11 (78%, p=.001) and for high intensity happiness [F(2, 84)=4.28, p=.02, η^2=.09] where 6-7 displayed significantly lower rates of accuracy (71%) than 8-9 (89%, p=.01) and 10-11 (87%, p=.02).

A significant age effect was also shown in fearful faces of high valence [F(2, 84)=5.18, p=.008, η^2=.11] with children aged 6-7 being significantly less accurate than children aged 10-11 (34% vs 57%, p=.002). Additionally, in overall disgust [F(2, 84)=13.46, p<.0001, η^2=.24] children aged 6-7 (56% correct identification) were significantly less accurate than their counterparts aged 8-9 (74%, p=.001) and 10-11 years-old (78%, p<.0001). For low intensity disgust [F(2, 84)=3.91, p=.02, η^2=.08] young children were significantly less accurate than 10-11 years old (34% vs 58%, p=.007). Similarly, for medium disgust [F(2, 84)=13.76, p<.0001, η^2=.25] those aged 6-7 (42%) and those aged 8-9 (55%) were significantly less accurate than those aged 10-11 (81%, p<.0001 and p=.001 respectively). For high intensity disgust [F(2, 84)= 5.24, p=.007, η^2=.11] 6-7 years old (66% accuracy) were significantly less accurate than 8-9 (79%, p=04) and 10-11 (86%, p=.002).

Younger children were also less accurate when assessing surprise faces [F(2, 84)=10.61, p<.0001, η^2=.20] with 10-11 (62% correct) having significantly greater rates of accuracy than 6-7 (46%, p<.0001) and 8-9 (52%, p=.006). This was also true for medium intensity surprise [F(2, 84)=9.05, p<.0001, η^2=.18] where older children (87% accuracy) had better performance than 6-7 (69%, p=.001) and 8-9 (62%, p<.0001). In high intensity surprise [F(2, 84)=6.42, p=.003, η^2=.13] younger children (72%) were significantly less accurate than 8-9 (88%, p=.01) and 10-11 (93%, p=.001). Finally, age had an effect on neutral faces [F(2, 84)=10.14, p<.0001, η^2=.19] with 6-7 (58% accurate) being significantly less accurate than 8-9 (81%, p=.002) and 10-11 (89%, p=.0001).

When interactions length of presentation by age were examined, significant effects (see Table 2) were observed on high intensity happy faces with children aged 10-11 increasing their performance from 500ms to 1000ms (82%500ms vs 93%1000ms), but children aged 8-9 (93%500ms vs 85%1000ms) actually decreasing their accuracy rates and children aged 6-7 (73%500ms vs 70%1000ms) displaying very similar rates regardless of length of presentation. For medium intensity sad faces a very similar effect was shown with younger children not being affected by time of exposure (18%500ms vs 23%1000ms), children 8-9 decreasing accuracy rates (25%500ms vs 15%1000ms) and older children improving accuracy in longer presentations (17%500ms vs 30%1000ms).

For overall disgust performance of children aged 10-11 was not altered across different times of stimuli exposure (80%500ms, 77%1000ms), however for children aged 6-7

(70%500ms, 44%1000ms) and for children aged 8-9 (85%500ms, 63%1000ms) longer exposure time led to lower accuracy rates. For medium disgust length of presentation had an effect only in children aged 8-9 years old with longer presentations being associated with greater accuracy (45%500ms, 65%1000ms). For high intensity disgust longer time of exposure led to more accurate assessments in children aged 10-11 (80%500ms, 92%1000ms) but to less accurate evaluations in younger children (6-7: 70%500ms, 63%1000ms; 8-9 85%500ms, 73%1000ms). Finally, older children benefited from longer exposure time in angry faces (41%500ms, 60%1000ms), and minor effects were observed in younger children (6-7: 37%500ms, 43%1000ms; 8-9: 46%500ms, 53%1000ms).

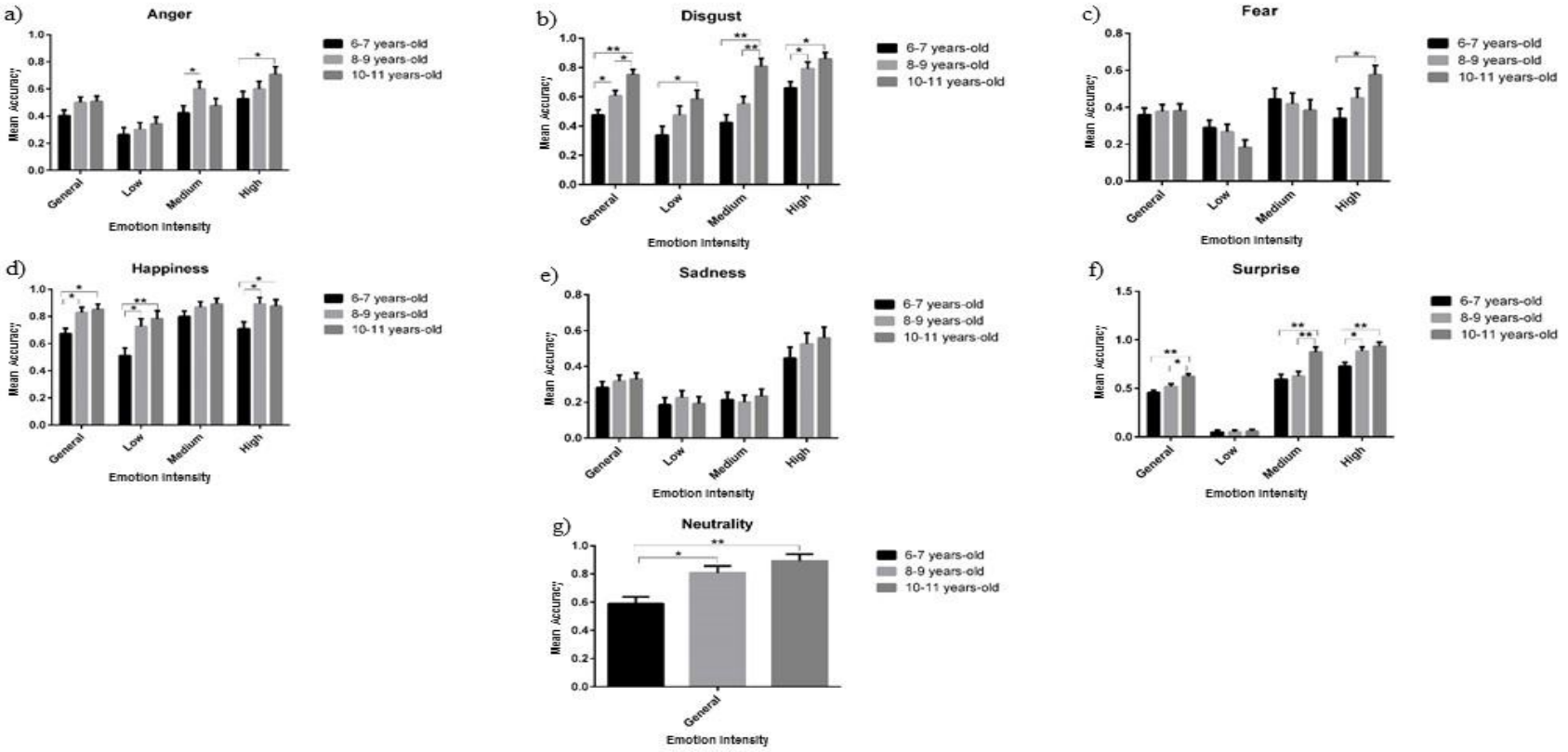

Figure 2. Mean accuracy of emotions response by each age group.

Note: *p<.05

**p<.001

Sex effect

Sex had no significant main effect in any of the target emotions neither overall or in the specific valences (all p´s >.07). Two significant interactions length of presentation by sex were observed. On medium intensity fear faces boys increased their accuracy rates in longer exposure time (36%500ms, 43%1000ms) whereas girls decreased their rates of correct identification (50%500ms, 36%1000ms). On medium disgust faces the opposite scenario was found with boys decreasing accuracy at 1000ms (63%500ms, 57%1000ms) and girls increasing performance (52%500ms, 64%1000ms).

Table 2. Effects of length of presentation, length of presentation by sex and length of presentation by age on accuracy scores

	500ms mean (SD)	1000ms Mean (SD)	Length of presentation effect	Length *sex effect	Length *age effect
HAPPINESS	0.78 (.23)	0.78 (.26)	F(1, 84)=.125, p=.725, η^2=.001	F(1, 84)=.003, p=.958, η^2=.000	F(2, 84)=1.979, p=.145, η^2=.045
Low	0.64 (.37)	0.70 (.40)	F(1, 84)=1.996, p=.161, η^2=.023	F(1, 84)=.022, p=.882, η^2=.000	F(2, 84)=1581, p=.212, η^2=.036
Medium	0.87 (.26)	0.83 (.29)	F(1, 84)=1.204, p=.276, η^2=.014	F(1, 84)=1.204, p=.276, η^2=.014	F(2, 84)=2.535, p=.085, η^2=.057
High	0.82 (.31)	0.82 (.31)	F(1, 84)=.006, p=.938, η^2=.000	F(1, 84)=1.357, p=.247, η^2=.016	**F(2, 84)=4.281, p=.017, η^2=.093**
SADNESS	0.29 (.20)	0.32 (.21)	F(1, 84)=2.418, p=.124, η^2=.028	F(1, 84)=.332, p=.566, η^2=.004	F(2, 84)=.815, p=.446, η^2=.019
Low	0.20 (.24)	0.20 (.24)	F(1, 84)=.001, p=.980, η^2=.000	F(1, 84)=1.394, p=.241, η^2=.016	F(2, 84)=.818, p=.445, η^2=.019
Medium	0.20 (.26)	0.22 (.29)	F(1, 84)=.614, p=.436, η^2=.007	F(1, 84)=.015, p=.903, η^2=.000	**F(2, 84)=3.604, p=.031, η^2=.079**
High	0.47 (.39)	0.53 (.41)	F(1, 84)=1.867, p=.175, η^2=.022	F(1, 84)=.017, p=.896, η^2=.000	F(2, 84)=.858, p=.428, η^2=.020
FEAR	0.38 (.23)	0.36 (.22)	F(1, 84)=.504, p=.480, η^2=.006	F(1, 84)=2.032, p=.158, η^2=.024	F(2, 84)=1.795, p=.173, η^2=.041
Low	0.25 (.29)	0.23 (.29)	F(1, 84)=.251, p=.618, η^2=.003	F(1, 84)=2.378, p=.127, η^2=.028	F(1, 84)=1.455, p=.239, η^2=.033
Medium	0.43 (.38)	0.39 (.37)	F(1, 84)=.867, p=.354, η^2=.010	**F(1, 84)=6.681, p=.011, η^2=.074**	F(1, 84)=1.235, p=.296, η^2=.029
High	0.45 (.34)	0.45 (.36)	F(1, 84)=.004, p=.947, η^2=.000	F(1, 84)=2.860, p=.095, η^2=.033	F(1, 84)=.795, p=.455, η^2=.019
DISGUST	0.60 (.24)	0.61 (.28)	F(1, 84)=.055, p=.815, η^2=.001	F(1, 84)=2.020, p=.159, η^2=.023	**F(2, 84)=3.202, p=.046, η^2=.071**
Low	0.46 (.39)	0.47 (.43)	F(1, 84)=.033, p=.856, η^2=.000	F(1, 84)=.277, p=.600, η^2=.033	F(1, 84)=1.269, p=.286, η^2=.029
Medium	0.57 (.37)	0.61 (.39)	F(1, 84)=.553, p=.459, η^2=.007	**F(1, 84)=4.879, p=.030, η^2=.055**	**F(1, 84)=4.509, p=.014, η^2=.097**
High	0.78 (.28)	0.76 (.33)	F(1, 84)=.356, p=.552, η^2=.004	F(1, 84)=.072, p=.790, η^2=.001	**F(1, 84)=3.829, p=.026, η^2=.084**
ANGER	0.41 (.23)	0.52 (.24)	**F(1, 84)=21.751, p=.000, η^2=.206**	F(1, 84)=.391, p=.533, η^2=.005	**F(2, 84)=3.781, p=.027, η^2=.083**
Low	0.28 (.32)	0.31 (.35)	F(1, 84)=.667, p=.416, η^2=.008	F(1, 84)=1.624, p=.206, η^2=.019	F(1, 84)=.429, p=.653, η^2=.010
Medium	0.42 (.35)	0.57 (.38)	**F(1, 84)=13.133, p=.000, η^2=.135**	F(1, 84)=.102, p=.750, η^2=.001	F(1, 84)=1.231, p=.297, η^2=.028
High	0.54 (.34)	0.67 (.38)	**F(1, 84)=10.926, p=.001, η^2=.115**	F(1, 84)=.289, p=.592, η^2=.003	F(1, 84)=2.445, p=.093, η^2=.055
SURPRISE	0.52 (.19)	0.53 (.17)	F(1, 84)=.159, p=.691, η^2=.002	F(1, 84)=1.118, p=.293, η^2=.013	F(2, 84)=.702, p=.498, η^2=.016
Low	0.07 (.17)	0.03 (.12)	F(1, 84)=2.797, p=.098, η^2=.032	F(1, 84)=1.406, p=.239, η^2=.016	F(1, 84)=.068, p=.935, η^2=.002
Medium	0.67 (.36)	0.72 (.34)	F(1, 84)=1.539, p=.218, η^2=.018	F(1, 84)=1.539, p=.218, η^2=.018	F(1, 84)=.698, p=.500, η^2=.016
High	0.83 (.30)	0.85 (.30)	F(1, 84)=187, p=.667, η^2=.002	F(1, 84)=1.666, p=.200, η^2=.019	F(1, 84)=445, p=.642, η^2=.010
NEUTRAL	0.75 (.35)	0.77 (.33)	F(1, 84)=.169, p=.682, η^2=.002	F(1, 84)=.199, p=.656, η^2=.002	F(2, 84)=.697, p=.501, η^2=.016

Emotion Intensity

Children tended to follow the expected pattern of intensity assignment with low intensity faces getting the lower intensity scores, medium intensity faces receiving the average scores and high intensity faces receiving greater scores. The two exceptions were sad faces at 1000ms and fear faces at 500ms where medium faces got a lower intensity score than low intensity faces. Nevertheless, it is worth nothing that a central tendency was observed with intensity attribution having a restricted range for most emotions. The better distribution was observed in happy and angry faces where low intensity faces were on average below 2, medium intensity were very close to 2 and high intensity were above 2.5 (see Table 3).

Length of presentation effect

Length of presentation had a significant effect on medium intensity happy faces and on medium intensity surprise faces. In both cases children´s performance was better at 500ms with average scores very close to the expected 2points of intensity. At 1000ms children tended to overrate intensities with average scores of 2.2 in happy faces and 2.3 in surprise.

Age effect

Very few significant age effects were observed. To date, in low intensity happy faces which had an expected intensity of 1 children aged 6-7 attributed significantly higher intensities and were more distant of the expected intensity [$F(2, 57)=9.58$, $p<.0001$, $\eta^2=.25$; 6-7 M=2.26] than children aged 8-9 (M=1.75, $p=.008$) and 10-11 (M=1.46, $p=<.0001$). On low intensity fear faces a similar pattern was observed [$F(2, 14)=4.25$, $p=.04$, $\eta^2=.38$] with 6-7 years old (M=2.33) and 8-9 years old (M=2.11) attributing greater intensities than 10-11 years old (M=1.39, $p=.01$ and $p=.04$, respectively). On high intensity disgust [$F(2, 74)=3.55$, $p=.04$, $\eta^2=.09$] again older children were closer to the expected intensity having attributed higher scores (M=2.67) than their younger counterparts (8-9 M=2.42, $p=.05$; 6-7 M=2.33, $p=.01$).

Additionally, a significant length of presentation by age was observed in high intensity disgust. At 6-7 years old children attributed higher intensities at 500ms (500ms M=2.46, 1000ms M=2.21). At 8-9 years old greater intensities were observed at longer presentations (500ms M=2.27, 1000ms M=2.57) and at 10-11 years old there was no difference in intensity attribution across exposure times (500ms M=2.66, 1000ms M=2.68).

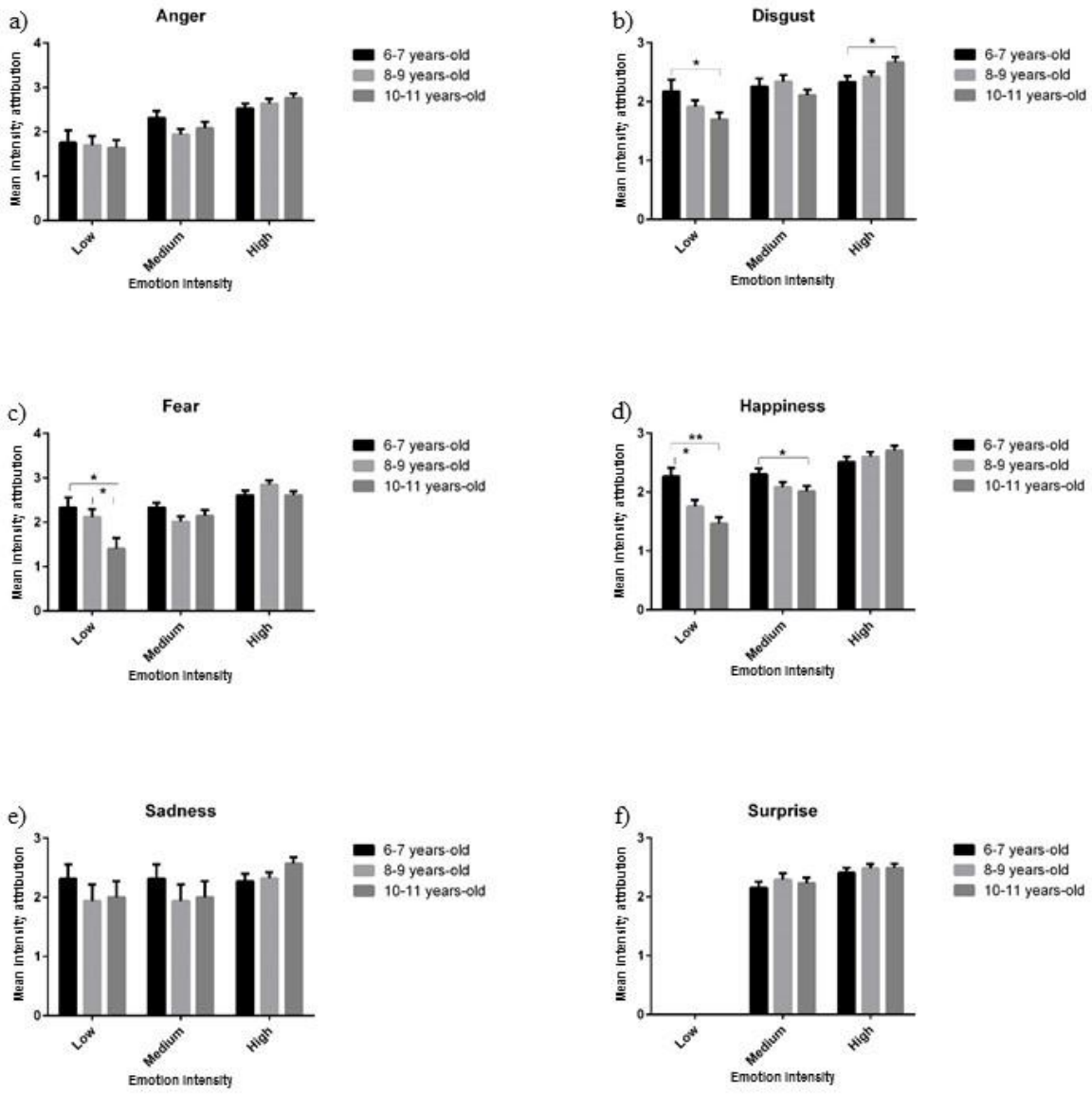

Figure 3. Mean attributed intensity scores for each emotion by child age

Note: *p<.05

**p<.001

Sex effect

Sex had no significant effect in any of the emotion intensities (all *p´*s >.06). A significant sex by age interaction was observed in high intensity sad faces [F(2, 40)=4.37, *p*=.02, η^2=.18]. At 6-7 years boys attributed higher scores and were closer to the expected intensity (boys M=2.54, girls M=2.00). At 8-9 years old the opposite scenario was observed (boys M=2.11, girls M=2.53) and at 10-11 both sexes were close to the expected intensity (e.g. 3) with a slight advantage for girls (boys=2.50, girls=2.64). Finally, a significant length of presentation by sex effect was observed in high intensity disgust faces with boys attributing higher scores than girls at 500ms, but girls outperforming boys at 1000ms (500ms boys M=2.59, girls M=2.33; 1000ms boys M=2.42, girls M=2.55).

Table 3. Effects of length of presentation, length of presentation by sex and length of presentation by age on intensity scores

	500ms mean(SD)	1000ms mean(SD)	Length of presentation effect	Length *sex effect	Length *age effect
HAPPINESS					
Low	1.76 (.71)	1.73 (.68)	F(1, 57)=.123, p=.727, η^2=.002	F(1, 57)=.009, p=.926, η^2=.000	F(2, 57)=.079, p=.924, η^2=.003
Medium	2.04 (.55)	2.20 (.60)	**F(1, 76)=5.661, p=.020, η^2=.069**	F(1, 76)=.421, p=.518, η^2=.006	F(2, 76)=.709, p=.496, η^2=.018
High	2.58 (.54)	2.65 (.51)	F(1, 74)=1.389, p=.242, η^2=.018	F(1, 74)=.008, p=.929, η^2=.000	F(2, 74)=.026, p=.975, η^2=.001
SADNESS					
Low	2.00 (.78)	2.20 (.72)	F(1, 18)=.045, p=.834, η^2=.002	F(1, 18)=.607, p=.446, η^2=.033	F(2, 18)=1.486, p=.253, η^2=.124
Medium	2.09 (.70)	2.14 (.72)	F(1, 15)=.228, p=.640, η^2=.015	F(1, 15)=.152, p=.702, η^2=.010	F(2, 15)=1.101, p=.358, η^2=.128
High	2.35 (.62)	2.42 (.62)	F(1, 40)=.419, p=.521, η^2=.010	F(1, 40)=1.080, p=.305, η^2=.026	F(2, 40)=.793, p=.459, η^2=.038
FEAR					
Low	2.22 (.83)	1.82 (.81)	F(1, 14)=1.635, p=.222, η^2=.105	F(1, 14)=.529, p=.479, η^2=.036	F(2, 14)=.063, p=.939, η^2=.009
Medium	2.15 (.61)	2.18 (.67)	F(1, 37)=.010, p=.922, η^2=.000	F(1, 37)=.943, p=.338, η^2=.025	F(2, 37)=1.501, p=.236, η^2=.075
High	2.61 (.56)	2.73 (.45)	F(1, 47)=1.903, p=.174, η^2=.039	F(1, 47)=1.441, p=.236, η^2=.030	F(2, 47)=.151, p=.860, η^2=.006
DISGUST					
Low	2.02 (.66)	1.77 (.65)	F(1, 34)=.157, p=.695, η^2=.005	F(1, 34)=2.085, p=.158, η^2=.058	F(2, 34)=3.198, p=.053, η^2=.158
Medium	2.22 (.54)	2.20 (.58)	F(1, 55)=.159, p=.691, η^2=.003	F(1, 55)=1.372, p=.246, η^2=.024	F(2, 55)=.233, p=.793, η^2=.008
High	2.44 (.66)	2.50 (.60)	F(1, 74)=.078, p=.781, η^2=.001	**F(1, 74)=4.741, p=.033, η^2=.060**	**F(2, 74)=.3.232, p=.045, η^2=.080**
ANGER					
Low	1.60 (.76)	1.73 (.73)	F(1, 23)=.609, p=.443, η^2=.026	F(1, 23)=2.820, p=.107, η^2=.109	F(2, 23)=2.657, p=.092, η^2=.188
Medium	1.99 (.71)	2.18 (.70)	F(1, 47)=3.510, p=.067, η^2=.069	F(1, 47)=.483, p=.490, η^2=.010	F(2, 47)=1.412, p=.254, η^2=.057
High	2.64 (.55)	2.64 (.64)	F(1, 58)=.059, p=.809, η^2=.001	F(1, 58)=1.325, p=.254, η^2=.022	F(2, 58)=1.720, p=.188, η^2=.056
SURPRISE					
Low	-	-	-	-	-
Medium	2.09 (.66)	2.33 (.59)	**F(1, 63)=5.741, p=.020, η^2=.084**	F(1, 63)=.080, p=.778, η^2=.001	F(2, 63)=5.470, p=.238, η^2=.045
High	2.40 (.53)	2.51 (.48)	F(1, 71)=2.141, p=.148, η^2=.029	F(1, 71)=.010, p=.921, η^2=.000	F(2, 71)=.975, p=.382, η^2=.027

Discussion

This article aimed to investigate the development of emotional face expressions recognition ability in children between six and 11 years-old. We expected that happiness is the first emotion to be identified by all ages, followed in sequence by anger, sadness, fear, disgust and surprise. Data showed to concur with studies already published, except for surprise. We also aimed to investigate the effect of age, sex and length of duration on this ability expecting 10-11 years-old group to have the best results followed by 8-9 years-old and 6-7 years-old with girls showing an advantage and better accuracy at 1000ms. As expected, development of emotional face expressions recognition followed childhood chronological course, since 10-11 years-old group showed higher accuracy scores than 8-9 and 6-7 years-old groups. Nevertheless, results did not corroborate a female advantage neither a better accuracy at 1000ms of exposure.

Development of emotional face expressions recognition

Happiness was the easiest expression, being highly recognized by all ages and in all intensities. This result corroborates previous studies (Gao & Maurer, 2009; Herba et al., 2008; Mancini et al., 2013). Facility in recognize happiness expressions is explained for being the most different expression between the six basic emotions (Ekman, Friesen, & J.C., 2002) and by the frequent amount of exposure that children experience since birth (Batty & Taylor, 2006).

Disgust and anger also had higher accuracy scores and were better recognized in high intensities which are consistent with concurring with literature (Kessels et al., 2013; Richards et al., 2007). These emotion expressions have high evolutionary signal value of survival, as anger prepares the mechanism fight or flight and disgust prevents the ingestion of rotten or poisonous foods. Fear was the third face expression more easily, albeit average accuracy was not extremely high (38%500ms vs 36%1000ms) with greater accuracy scores in medium and high intensities, again corroborating previous studies (Gao & Maurer, 2009, 2010; Kessels et al., 2013). Fear shares the same evolutionary signal value of survival of anger and disgust, justifying the ease recognition. Recognizing fear expression in others indicates potential environmental threat, preparing subsequent defense. Means of accuracy lower than expected may be justified by high misidentification with surprise, especially medium and high fear which shares the open mouth feature. This fact may be inflated by the schematic faces used as anchors – fear faces have a mid-closed mouth with showing teeth and surprise faces have an

open mouth. Thus, participants may have compared fear faces and schematic face, misidentificating it as surprise. In this sense, surprise was the fourth out of the six emotions more easily recognized contradicting our first hypothesis. This may be explained by the same issues discussed with regards to fear faces– comparison with schematic face turned surprise the only possible answer, as it was the only face with open mouth.

Sadness demonstrated similar results from expected (De Sonneville et al., 2002; Durand et al., 2007) with a low mean accuracy in all ages. Previous studies have also found similar results with better accuracy in sad faces of high intensity than medium and low intensities (Gao & Maurer, 2009, 2010; Herba et al., 2008; Kessels et al., 2013; Mancini et al., 2013; Naruse et al., 2013). Results from the current study can be explained by high misidentification with all other emotions, aspect predicted by previous studies (Gao & Maurer, 2010; Kessels et al., 2013), or may also indicate that images selected for this experiment were dubious or of not extreme high intensities (e.g. none of the pictures depicted a sad face with tears).

Age, sex and length of presentation effect

Participants by 10 and 11 years-old showed the highest means of accuracy of emotion and the best attribution of intensities compared to expected answers. Children from 8-9 years-old group had by and large a similar performance to 10-11 years-old on emotion accuracy and intensity attribution with few significant differences between these two age groups. However, younger children, from 6-7 years-old group, have the lowest means in both emotion accuracy and intensity attribution. Notably, 6-7 years-old group presents significant differences when compared means with other age groups, especially on emotion accuracy and even on the easier recognizing emotion – happiness. This result corroborates a large number of studies, which demonstrate a direct correlation with neural maturation and cognitive processes improvement (Batty & Taylor, 2006; Durand et al., 2007; Gao & Maurer, 2010; Mancini et al., 2013; Naruse et al., 2013), justifying a chronological pattern of emotional face processing development.

Regardless of studies showing existence of sex effects, data from the current article denotes a non-existence of a female advantage. This data differs from hypothesized based on published studies (McClure, 2000; Rehnman & Herlitz, 2007; Wright & Sladden, 2003) which consider the existence of a female advantage in recognizing emotional faces. However, a consistent number of studies corroborates our results (Calvo & Lundqvist, 2008; De Sonneville et al., 2002; Gao & Maurer, 2009, 2010; Herba et al., 2008; Herba, Landau,

Russell, Ecker, & Phillips, 2006; Mancini et al., 2013; Vicari, Reilly, Pasqualetti, Vizzotto, & Caltagirone, 2000), arguing that methodological variability may influence results comparison, as well as neural maturation is under development in childhood, thus, an female advantage may appear only after puberty (Kessels et al., 2013; McClure, 2000).

There is no consensus about length of presentation of stimuli in this kind of experiment. Each study use a different duration in different methods, therefore, it is not possible yet to postulate appropriate lengths of presentation (Batty et al., 2011; Deeley et al., 2008). However, it was expected that children were more accurate at 1000ms as with a longer length they could process the information better. Despite this, results showed that there is no difference between the two tested lengths and, surprisingly, that the only significant difference denotes a better accuracy at 500ms - on medium intensity happy faces and on medium intensity surprise faces. This data can be justified by the fact that children may have over thought and got confused about the right answer.

Limitations

Developmental patterns and accuracy results presented in this article may be affected by the forced-choice procedure. This method possibly affected children responses as there were no options for different answers, thus, children may randomly chosen an option in order to continue the experiment. A free labeling procedure allowing children to provide an own label for the expression is recommended for future researches and replications. Another limitation is the use of schematic faces to help younger children to see options of answer. Although this method has been used in studies as Gao and Maurer (2010), experimenters realized that a significant number of participants, especially from 6-7 years-old group, clearly answered based on comparisons between database image and schematic faces. This strategy possibly increased mean accuracy, therefore results from younger participants may be questionable. It is also recommended that future studies include a larger sample which allows more robust results. Furthermore, it is recommended to aggregate an adult group to enable performance comparison with a well established results group and use an additional database with adult images to investigate and control an possible own-age-bias (Rhodes & Anastasi, 2012).

Conclusions

To the best of our knowledge, this study is the first investigation of developmental markers of emotional face expression recognition and the effect of age and sex in children

between six and 11 years-old through an experiment using children images expressing the six basic emotions in three intensities and neutrality. Results indicated that happiness is the first emotion to be recognized,followed by crucial emotions for survival (disgust, anger and fear) and surprise and, lastly, sadness. This development also follows chronological course, as younger children – 6-7 years-old group – presented low accuracy means, while children close to puberty – 10-11 years-old group – showed higher levels of accuracy. Nevertheless, data support a non-existence of female advantage. Future studies could use method and stimuli described above for replications seeking for patters and the establishment of developmental markers. In addition, it is fundamental to develop more studies focusing on neural mechanisms and effects of familiarity, race, age, gender and, mostly, psychopathologies.

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4. General Discussion

4.1. Summary of Results

The main objective of this dissertation was to investigate developmental patterns of recognition of emotional faces in children aged between six and 11 years-old and the effect of age and gender on it. In this sense, a second objective was formulated to enable the study. Thus, we also aimed to develop a database comprising children emotional faces.

”Child Emotions Picture Set (CEPS) – Development of a database of children’s emotional expression”, study 1, consisted in acquiring images from facial expressions of children and determining through a panel of experts adequate emotion label and intensity determination. The final version of CEPS consists of 225 photos of 17 children, boys and girls, aged six to 11 years-old from multiracial backgrounds posing or naturally expressing the six basic emotions – happiness, fear, disgust, surprise, sadness and fear – in three intensities – low, medium and high – and neutrality.

The second study, “Emotional Face Expressions Recognition in Childhood: developmental markers, age effect and gender effect”, presented similar results in regard of already published data. As expected, happiness had the higher means of accuracy followed by disgust faces. Surprise demonstrated to be the third easier face to be recognized, showing the most different patterns that we hypothesized. Children denote to have more difficult recognizing anger and fear. Sadness is the most difficult and seems to be the last emotion to be developed as its means were the lowest ones. As also expected, development of emotional face expressions recognition denote to follow childhood chronological course, since 10-11 years-old group showed the highest accuracy means and 6-7 years-old group had the lowest means of accuracy. However, contradicting our expectations, results demonstrate a non-existence of a female advantage neither a better accuracy at 1000ms of exposure.

4.2. Limitations and Recommendations for Future Research

Some limitations must be flagged in both studies. On Study 1, children who participated in image acquisition were not actors and all of them were from southern Brazil, which made not possible to include a variety of facial features. Some of the participants also complaint that they could not deliberately make expressions as wrinkled nose and raised and straightened eyebrows. Besides this, we could not be sure if the target emotion really was the induced emotion, since videos were subjective. Additionally, we could not use the same emotion induction method for all emotions. Regarding expert ratings, there is a concern about

the forced choice design, which may have biased raters choice, since the evaluation did not include an option to photos judged as not fitting any of the seven targeted emotions. Future databases must goal a larger sample of multiracial children, use already validated videos for emotion induction and include options as "none of the above" or variables as "Agreement/Disagreement rate" and "Representativeness" on expert ratings.

In regard of study 2, results may be affected by the forced-choice procedure either and the use of schematic faces on label stage. We recommend future studies to use a free labeling procedure which allows children to provide an own label for the expression is recommended. It is recommended, either, a larger sample which allows more robust results. Furthermore, adding an adult group enable performance comparison with a well established results group and using an additional database with adult images allows investigation and control of a possible own-age-bias (Rhodes & Anastasi, 2012).

4.3. Conclusions

Recognizing emotions in others through face expressions is the ability to perceive relevant information through specific contraction of facial muscles. This feature makes it one of the most important ways of non-verbal communication (Batty & Taylor, 2006; Donato, Bartlett, Hager, Ekman, & Sejnowski, 1999; Rhodes & Anastasi, 2012; Thomas, De Bellis, Graham, & LaBar, 2007), allowing an adequate adaptation to the social environment (Gao & Maurer, 2009; Thomas et al., 2007). The accurate recognition of emotional face expressions permits inferring the felt emotion (Ekman, Friesen, & Ancoli, 1980; Gao & Maurer, 2009), making predictions about other's action (Sze, Goodkind, Gyurak, & Levenson, 2012) and adjusting assertively the respondent behavior (Gosselin & Pelissier, 1996). In this sense, recognizing emotional face expressions are either important in childhood when infants start social experiences in a complex environment and need to have an effective communication at every moment (Cheal & Rutherford, 2011; Widen & Russell, 2008). Despite its importance throughout social development, data already published present inconsistent results due to scarce number of studies focused on development of emotional face expressions recognition and great variability of methods.

The present dissertation aimed to fill these gaps providing a complete set of children images expressing the six basic emotions in three intensities. CEPS contributes for the scientific field by making available a child face stimuli set, which is intended to be used in further developmental studies – including neuropsychology, psychiatry and pediatrics – and also enables the development of cross-cultural studies in the field. We also provide further

evidence about developmental markers of emotional face expressions recognition and the chronological course that it follows through childhood showing the non-existence of a female advantage on this skill and that longer exposure to stimuli does not facilitate the recognition. This method is susceptible to replication, allowing the establishment of developmental markers of emotional face expressions recognition. It is, therefore, fundamental to develop more studies focusing on neural mechanisms and effects of familiarity, race, age, gender and, mostly, psychopathologies. Such kinds of investigations are of highly interest for determining differences in social and emotional development and the identification of early signs of disruptive symptoms.

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ANEXOS

- **ANEXO I –** Documento de aprovação do projeto no comitê de ética em pesquisa da PUCRS
- **ANEXO II –** Parecer de aprovação da comissão científica da faculdade de psicologia PUCRS
- **ANEXO III –** Comprovante de submissão do manuscrito “Child Emotions Picture Set (CEPS) – Development of a database of children’s emotional expressions”

ANEXO I

PONTIFÍCIA UNIVERSIDADE CATÓLICA DO RIO GRANDE DO SUL - PUC/RS

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Expressões Faciais na Infância: Construção de um Banco de Imagens e Investigação do Efeito da Idade, do Sexo e da Configuração Familiar

Pesquisador: Adriane Arteche

Área Temática:

Versão: 3

CAAE: 26068114.0.0000.5336

Instituição Proponente: UNIAO BRASILEIRA DE EDUCACAO E ASSISTENCIA

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 723.084

Data da Relatoria: 09/08/2014

Apresentação do Projeto:

Sem ressalvas ao que foi colocado no parecer anterior.

Objetivo da Pesquisa:

Sem ressalvas ao que foi colocado no parecer anterior.

Avaliação dos Riscos e Benefícios:

Sem ressalvas ao que foi colocado no parecer anterior.

Comentários e Considerações sobre a Pesquisa:

Sem ressalvas.

Considerações sobre os Termos de apresentação obrigatória:

Sem ressalvas.

Recomendações:

Recomenda-se fortemente a alteração, em todos os Termos de Consentimento Livre e Esclarecido bem como nos Termos de Assentimento, do endereço do Comitê de Ética e Pesquisa da PUCRS (CEP). O atual endereço, constante da página do CEP, é:

Av. Ipiranga 6681, Prédio 40 - Sala 505

Porto Alegre /RS - Brasil. O telefone continua o mesmo.

Endereço: Av.Ipiranga, 6681, prédio 40, sala 505
Bairro: Partenon **CEP:** 90.619-900
UF: RS **Município:** PORTO ALEGRE
Telefone: (51)3320-3345 **Fax:** (51)3320-3345 **E-mail:** cep@pucrs.br

Atualizar também o horário de atendimento, conforme a página do CEP:
De segunda a sexta-feira
Manhã: 8h30min às 12h
Tarde: 13h30min às 17h (Expediente Interno)

Conclusões ou Pendências e Lista de Inadequações:

As pendências elencadas em parecer anterior encontram-se superadas. É importante ver a recomendação constante do item específico, acima.

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

Considerações Finais a critério do CEP:

PORTO ALEGRE, 19 de Julho de 2014

Assinado por:
Rodolfo Herberto Schneider
(Coordenador)

Endereço: Av.Ipiranga, 6681, prédio 40, sala 505
Bairro: Partenon **CEP:** 90.619-900
UF: RS **Município:** PORTO ALEGRE
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ANEXO II

Pontifícia Universidade Católica do Rio Grande do Sul
Faculdade de Psicologia
Programa de Pós-Graduação em Psicologia

Ofício 002/2014 – PRB

Porto Alegre, 13 de janeiro de 2014.

Senhor(a) Pesquisador(a)

A Comissão Científica da Faculdade de Psicologia da PUCRS apreciou e aprovou seu protocolo intitulado ""**Expressões Faciais na Infância: Construção de um Banco de Imagens e Investigação do Efeito da Idade, do Sexo e da Configuração Familiar**""

Dessa Maneira a Comissão Científica encaminha o material para apreciação do Comitê de Ética da PUCRS.

Atenciosamente,

Prof. Dr. Rodrigo Grassi de Oliveira
Coordenador da Comissão Científica da Faculdade de Psicologia

Ilmo(a) Sr(a)
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Psychology & Neuroscience - Manuscript ID PN-2014-0098

1 mensagem

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Para: alineromani@gmail.com
Cc: alineromani@gmail.com, carolinemottin@hotmail.com, dc.hertzog@gmail.com, adriane.arteche@pucrs.br

30-Sep-2014

Dear Miss Romani-Sponchiado:

Your manuscript entitled "Child Emotions Picture Set (CEPS) – Development of a database of children's emotional expressions" has been successfully submitted online and is presently being given full consideration for publication in Psychology & Neuroscience.

Your manuscript ID is PN-2014-0098.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to ScholarOne Manuscripts at http://mc04.manuscriptcentral.com/pn-scielo and edit your user information as appropriate.

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Thank you for submitting your manuscript to Psychology & Neuroscience.

Sincerely,
Psychology & Neuroscience Editorial Office