



Recognition of Emotions through Cartoon Facial Expressions in Preschoolers

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Abstract

Objective: Recognition of children's emotions expressed on their faces and the faces of others is very important in children's social activities, including communicating the child's emotions. This study aims to develop a research instrument that can represent or mediate children in communicating their emotions.

Materials and Methods: This exploratory research begins with item development, expert review, and validation study. Data analysis was carried out through the Pearson validity test, Kuder-Richardson 20 reliability test and test-retest analysis, and MANOVA to see the main and interaction effects of the variables of age and sex of children.

Results: One hundred ninety-seven children aged 3-6 years were involved in a study that tested seven cartoon-like facial expressions. These seven items show valid ($r_{xy}=0.28-0.74$, $p<0.05$) and reliable ($r_{11}=0.912$, $p<0.05$) items.

Conclusion: This instrument is recommended for researchers to use for assessing children's emotions in a certain setting.

Keywords: Facial expression, emotion, child, preschool

Introduction

Emotional development is one aspect of development that occurs in individuals from birth to adulthood, where since birth, babies have learned about social smiles and crying as a form of communication about what they feel. Various kinds of emotions develop gradually and are shown by the increasing number of responses given and the child's growth and development, such as emotions of happiness, angry, sadness, surprise, afraid, and guilt.

Basic emotion theory proposes that humans have several emotions (e.g., fear, anger, joy, sadness) that are bio-

logically and psychologically "basic," each manifested in an organized repeating pattern of related behavioral components. Basic emotions are preserved because their biological and social functions are essential in human evolution and adaptation. Various fundamental theories of emotions developed along with the development of research, and from these various theories, experts propose seven basic emotions: fear, anger, joy, sadness, disgust, humiliation, and surprise. Emotion determination is based on an assessment of the same facial expressions produced when emotions arise spontaneously. Basic emotions are universal because humans express these emotions, not because of a cultural background but



rather a biological one. Therefore, facial expressions of basic emotions are universal, and one can easily read these expressions in people from different cultures.[1-3] The ability to recognize other people's expressions representing one's emotions is a skill that a child must possess. This ability will also support children in expressing and managing their own emotions.

Emotions play an essential role in the selection of responses when children act and go through a phenomenon. A scenario requiring children to assess their emotions is complex without a measuring instrument representing them. Currently, there is much circulation about the pictorial scale that gives the response value of emotion. For example, the Visual Analog Scale (VAS) is a psychometric measurement instrument for documenting the severity characteristics of disease-related symptoms in individual patients and using them to classify symptom severity (statistically quantifiable and reproducible). The VAS is more sensitive to small changes than a simple descriptive ordinal scale in which symptoms are rated, for example, mild or mild, moderate, or severe to excruciating.[4-7] This scale is most valuable when looking at changes in an individual for a particular symptom. Although it has been widely used, the VAS assessment cannot represent various emotional expressions.

In a setting, for example, in the dental setting, we generally know that the emotion that occurs is fear.[8,9] This makes us generalize that any child who cries or behaves negatively is classified as fearful. Nevertheless, could there be other emotions behind the child behaving like this? Therefore, we have developed a measuring instrument to help children express their emotions which are expected to be used in various dental settings.

Materials and Methods

Prior authorization for participants in the project was requested from parents or guardians, and the study was evaluated and approved by the Universitas Padjadjaran Ethics Research Committee.

Participants

The main participants in this study were 197 children (76 boys and 121 girls) aged 3-6 years (mean age 4.4 years SD 1.1) who came to the pediatric dental clinic. These children are new patients brought in by dental students throughout the 2016-2019 time period. The child is in good health, does not feel pain in the teeth or other body parts, and feels comfortable in the clinic environment. Informed consent was obtained before each interview from the child's parent/guardian.

The development of the Facial Expression Emotion Scale (FEES) instrument was divided into two phases: (1) initial item construction and evaluation and (2) refinement and repeated evaluation of the scale. This article describes the first phase of the development of this measuring tool. Three methodological steps are used in this phase: (a) item development, (b) expert review, and (c) validation study.

Item development

Cartoon-type facial hand-drawn picture based on Action Unit Descriptions regarding facial expressions.[10] Given that the instrument is aimed at the target population of preschool children, the basic premise for constructing expressions is clear, simple, and to the point to understand the meaning of the expressions displayed. As the first informal test to establish content validity, the instrument was presented to three experts in developmental psychology, communication science, and a character drawing to determine if any essential aspects were missing regarding the goals being pursued and which might not have been adequately addressed considered. This procedure resulted in item selection to reach 100% agreement. Then, this revised, and scaled-down instrument was given to a small randomly selected sample to analyze whether it was understandable to the children and to uncover any problems that had not been discovered before. This trial allows improving the refinement of the expression displayed by the image characters because the previous image causes comprehension problems. Overall, the measuring instrument represents the expression of the seven basic emotions (Fig. 1). Characters referring to a boy or girl are included, with only the haircut, eyelashes, and clothes worn (Fig. 2).

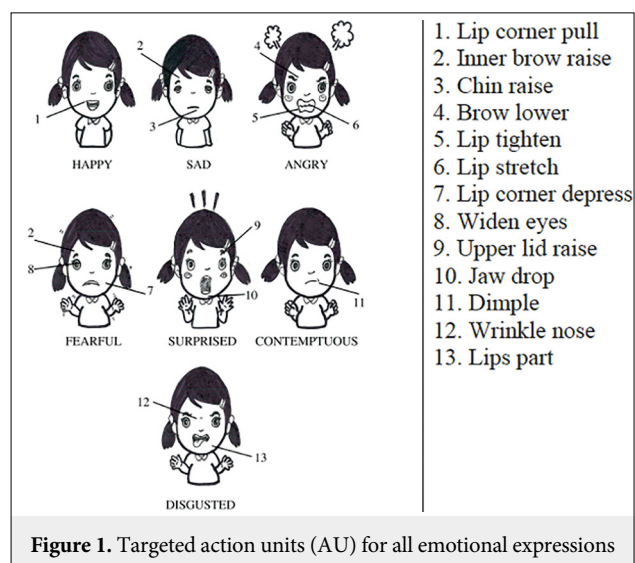


Figure 1. Targeted action units (AU) for all emotional expressions

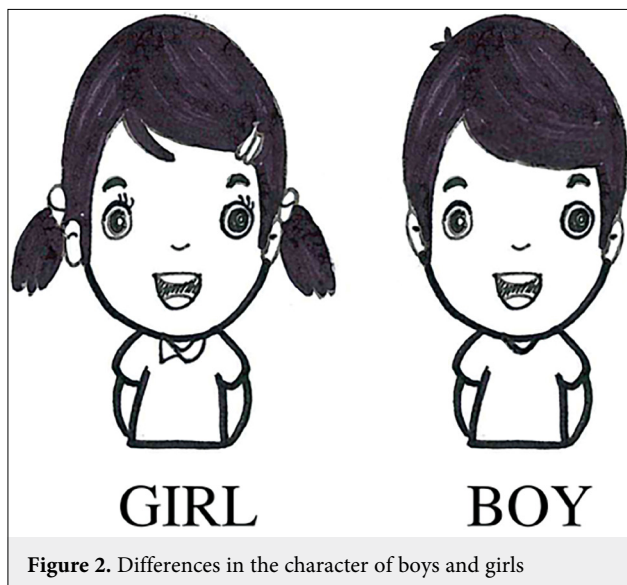


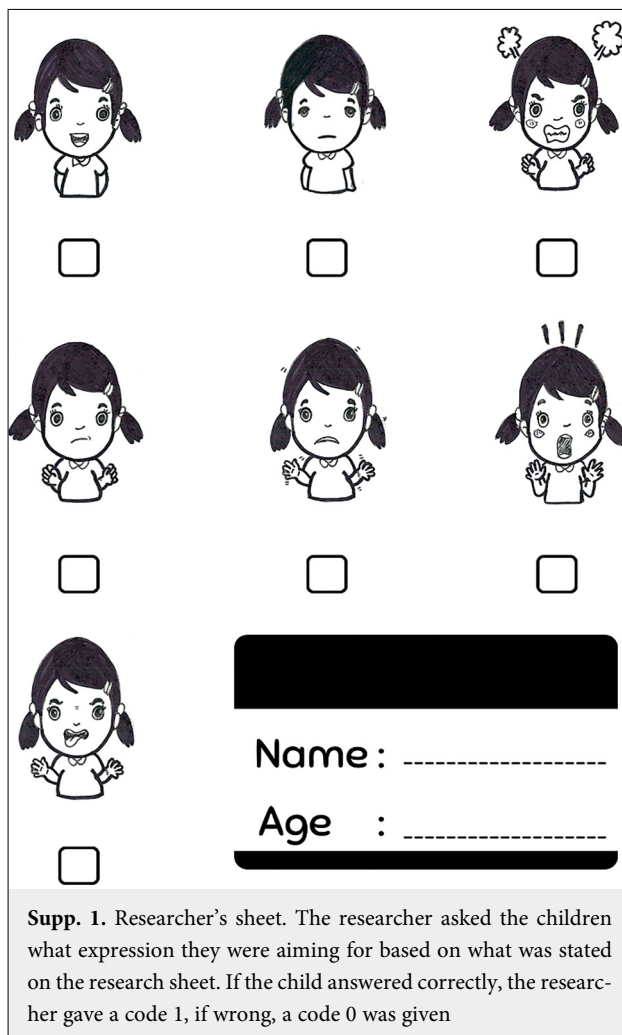
Figure 2. Differences in the character of boys and girls

The FEES measuring instrument used for this study were two sets of expression images (consisting of 1 set of female characters and one boy character, each with seven flashcards with one expression in each) which the children would respond to according to their gender. The correct answer is coded 1. The wrong answer or does not know is coded 0.

Procedure

This research was conducted at the pediatric dentistry clinic at the dental and oral hospital Universitas Padjadjaran. Parents/guardians of children were asked for informed consent before data collection. Before assigning the instrument to a definitive subject, the first complete set was administered to a separate pilot sample of 60 participants.[11,12] It was observed that some images still cause comprehension problems. This problem was corrected, and finally, an ideal instrument was produced, given to the final sample in this study. From the very beginning, we intended to draw the seven basic emotions according to the theory. The corrections made include deepening the smile on the "happy" emotion, adding a tongue image for the "disgusted" feeling, and adding a shaking line for the "fearful" emotion.

In the final administration, the participants were told how the research was going. The presentation and application of the instrument were carried out individually by the primary researcher, who read aloud the name of the expression as stated in the researcher's sheet (Supp. 1). Seven flashcards (Fig. 3) measuring 4x6 inches, each containing only one expression picture, are pasted on the blackboard that children can easily see. However, only three expression choices are shown as child choices for



Supp. 1. Researcher's sheet. The researcher asked the children what expression they were aiming for based on what was stated on the research sheet. If the child answered correctly, the researcher gave a code 1, if wrong, a code 0 was given

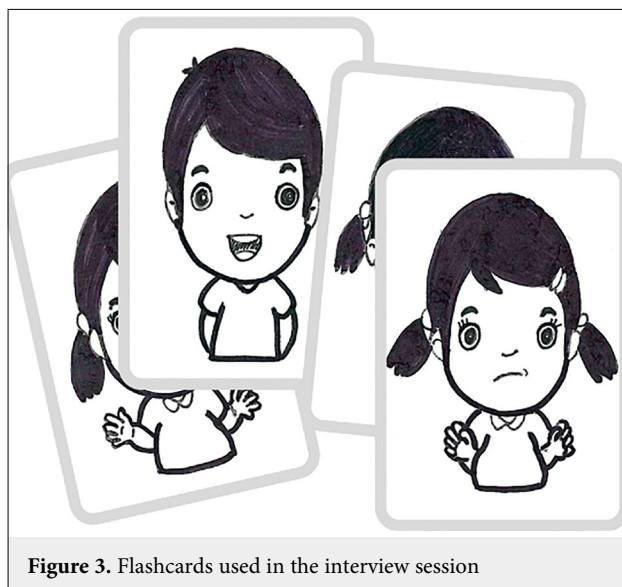









Figure 3. Flashcards used in the interview session

one item (Supp. 2). Finally, the child shows a flashcard containing facial expressions according to the researcher's question. The primary researcher will assess the

<p>1. Happy</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>	<p>3. Angry</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>	<p>5. Disgusted</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>
<p>2. Sad</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>	<p>4. Contemptuous</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>	<p>6. Fearful</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>
<p>7. Surprised</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>	<p>Supp. 2. Guidelines for the choice of children's answers held by the co-researcher. When the primary researcher mentions the name of the expression that the child must designate, the co-researcher will paste 3 flash cards containing the expression image in suppl 2 for the child to choose</p>	

researcher's sheet by filling in code 1 for correct answers and 0 for incorrect answers. The interview atmosphere was made fun and relaxed, and the children were not directed in answering. Each child took about 10-15 minutes to complete all seven expressions.

Data analysis

Descriptive analysis was done for means, standard deviation, and correlation of all participant variables. Next, the analysis of the internal consistency of the instrument (coefficient KR-20) was examined. For the reliability of this item, because it uses a dichotomous scale, i.e., only one correct answer, and an odd number of items, the Kuder-Richardson 20 is used. External consistency is obtained by test-retesting on 30 participants with a span of three months. The instrument's validity was analyzed using Pearson's bivariate correlation (Pearson's product-moment correlation) on SPSS 25.0 (IBM SPSS Statistics for Windows, Armonk, NY) software, where the score of each item was correlated with the total score. The total score is the sum of all item scores. Instrument items that are significantly correlated with the total score will indicate their likelihood to support and describe what has been designed to be disclosed (valid). If r is greater than or equal to (\geq) r -table (two-tailed test with sig. 0.05), the instrument or instrument item is significantly correlated with the total score.

Results

Psychometric properties

A descriptive analysis (mean and standard deviation) of all items was performed as the first step to maximizing scale variance and selecting items that presented high discriminatory power, high standard deviation, and an average score of the responses received. The result is that the standard deviation for contemptuous and disgusted is greater than the mean (Table 1). The standard deviation is a reflection of the average deviation of the data from the mean. Therefore, the standard deviation can describe how much variation the data has, where if the standard deviation value is greater than the mean value, it means that the mean value is a poor representation of the overall data. However, if the standard deviation value is smaller than the mean value, this indicates that the mean value can be used to represent the entire data.

Validity and reliability analysis

The instrument's validity shows that all items are valid with a low to high correlation (Table 2). Internal consistency displays the coefficient value of $r_{11} 0.912$, which indicates that this instrument is reliable. Meanwhile, for external consistency, the r -value obtained from tests-retest on 30 participants shows the number 0.469, greater than the r -table ($0.349, =0.05$). The score indicates that the instrument is reliable, which means that the instrument shows acceptable levels of stability (Table 3).

Table 1. Descriptive analysis of the item

	Happy	Sad	Angry	Contemptuous	Disgusted	Fearful	Surprised
n	197	197	197	197	197	197	197
mean	0.89	0.77	0.81	0.07	0.13	0.80	0.79
SD	0.309	0.421	0.392	0.249	0.334	0.403	0.411
Varians	0.096	0.177	0.153	0.062	0.011	0.016	0.169

Table 2. Pearson's correlation test result

	Happy	Sad	Angry	Contemptuous	Disgusted	Fearful	Surprised
rx _y	0.566	0.649	0.743	0.330	0.289	0.629	0.579
t-value	12.732	14.778	17.996	8.500	7.884	14.265	13.029
t-table	1.653						
	Valid	Valid	Valid	Valid	Valid	Valid	Valid
Category	Medium	High	High	Low	Low	High	Medium

It is declared valid if the t-value > t-table with a significance level of $p < 0.05$

Main effects and effects of interaction of gender and age

We performed MANOVA on the data from the sample, where the seven perceived expressions act as dependent variables and age and gender as independent variables. With regard to age, the results showed a significant difference, Wilks' Lambda=0.79, $F=2.15$, $p < 0.001$. Specifically, this difference existed for happy ($F=7.28$, $p < 0.001$), sad ($F=10.24$, $p < 0.001$), and angry ($F=8.01$, $p < 0.01$) items. No significant differences were found for the main effect of sex or age vs. sex interaction (Table 4).

Discussion

Because recognizing emotions through facial expressions can be important in a child's social development and is an inseparable component of the child's response to specific situations in his life, we tried to develop this instrument. A child can have one emotion simultaneously and display another emotion in the same state but at different times. The inability of children to express certain emotions often causes misunderstandings in those around them. For example, in the context of a dental setting, a child who cries or behaves negatively is often generalized out of fear. However, it is also possible for children to behave this way because they are angry with parents who are dishonest in saying they are going elsewhere instead of going to the dentist. A child who behaves negatively because of fear and anger will be different if the child can say it directly.

The main goal of developing this instrument is that if children can show the emotions, they feel in images representing their emotions, then non-verbal communication can be established. In addition, this instrument

Table 3. Item reliability

	Kuder-Richardson-20
Number of Items	7
Standard Deviation	1.976
Mean total score	4.254
The reliability coefficient (r_{11})	0.912
r-table	0.139
	Test-retest reliability
n	30
r	0.469
t-value ($\alpha=0.05$)	2.042
r-table	0.349

will be continued to the next phase to determine the level of emotion felt by the child. Thus, it will open up research opportunities to measure the happiness scale, sadness scale, and others on young children.

The ability to recognize and name one's own emotions and others according to facial expressions is an essential adaptive ability to survive and thrive in society. This ability is directly related to the way individuals interact with others and understand feelings and emotions in each context. This skill is even more critical in childhood, when the first social interactions occur before speech is fully developed.[13,14] Accurately decoding emotions from faces appear to be one of the primary mechanisms for understanding social information. In ontogenetic research, essential advances in facial emotion processing have been reported in the first year of life-for example; newborns appear to smile longer than neutral or fearful faces, and infants between 5 and 7 months of age exhibit an attentional bias toward fearful faces.[15,16]

Table 4. Multivariate analysis according to participants' age and sex

Variables	Main effects		Interaction effects
	Age	Sex	Age×sex
	F	F	F
Happy	7.28*	0.037	0.460
Sad	10.24*	0.018	0.287
Angry	8.01*	0.506	0.215
Contemptuous	0.044	0.041	1.140
Disgusted	0.128	0.146	1.024
Fearful	2.71	0.486	0.458
Surprised	2.77	0.618	0.632
Multivariate analysis			
Wilks' A	0.790*	0.992	0.944
Multivariate F	2.15	0.200	0.510

*p<0.001

The advantages of understanding emotions for healthy child development are apparent. Failure to recognize facial emotions is closely related to problems in child development. This failure is also a characteristic of some developmental disorders and can delay the primordial social skills necessary to adjust to life in society. Poor emotional knowledge in children has been associated with adverse outcomes, including poor social functioning, poor academic performance, and internalizing/externalizing behavior problems.[17,18]

The importance of having children's emotional expressions represented in databases to investigate the processing of these expressions during early development has given rise to research validating children's emotional facial devices that can be used in developmental research.[19-22] The available data set is in the form of genuine human child photos. Data in the form of cartoon images representing the original state is expected to stimulate children more in expressing their expressions because it can be formatted like a fun book. This is confirmed from the theory that children are more interested in cartoon content than traditional drawing methods (photos) because the visual effects are more challenging to children's imagination.[23]

Our data showed that age had an effect on the recognition of emotional expression in children (Wilks' Lambda=0.79, F=2.15 p<0.001). In detail, happiness, sadness, and anger are the expressions most recognized by children. This result is in line with other studies, which have also shown that recognition of happiness develops earlier, followed by other relatively basic emotions (e.g., sadness, anger) and then more complex emotions (e.g., surprise, shame, humiliation).[24,25]

Our research is not without its limitations, but it can be a window to open new research. Limitations include the method of data collection, which a researcher only carries out. It is hoped that further research can be carried out to develop this facial expression image dataset into a scale for measuring several emotions in children.

Conclusion

We conclude by highlighting the importance that our research and similar research that has been or is currently being conducted may have in our understanding of children's ability to recognize emotions through facial expressions. As this research is exploratory, there is a strong need for our students to use the FEES instrument in carrying out treatment during their education at a dental school. Therefore, we invite practitioners and researchers to explore and develop this FEES as a research instrument on the emotions of preschoolers.

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Conflict of Interest: None declared.

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