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A study of facially expressed emotions as a function of age, exposure time, and sex in children

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Abstract

Facial expressions and body language constitute a major component of communication in the human population. There are no studies in the dental literature that have examined children's ability to recognize facial expressions. The purpose of this study was to determine children's accuracy and latency to respond to facial expressions (photographs) as a function of age and sex. Sixty children were recruited randomly and placed into three groups according to their age (3, 6, and 9 years) with 20 children per group. They were shown photographs of three different emotions (happiness, anger, and sadness) expressed by actors at three different exposure times (0.2, 0.5, and 1.0 sec), tachistoscopically. The children's responses (accuracy and latency) were recorded. The results indicated that three year olds were significantly less accurate and took longer to respond than the older children. Factors that may have influenced the results and clinical implications are discussed.

Introduction

The literature related to facial emotions and expressions is prolific and multidisciplinary. Investigations have ranged from the impaired perceptual recognition of facial expressions in adults (Etcoff 1984) and children (Voeller et al. 1988) with pathologic dysfunctions to that of eye movements and habituation responses of infants exposed to audiovisual stimuli involving expressions of human emotions (Caron et al. 1988).

In the practice of pediatric dentistry the influence of nonverbal communication is common knowledge, although the extent of its occurrence is, possibly, naively underestimated and unappreciated (at a conscious level) by most professionals. There have been suggestions that facial expression must and does accompany verbal communication occurring between the patient and dentist (Pinkham and Paterson 1985). Implicit in this notion is that the professional expects the child to recognize relevant multimodal stimuli and respond in a fashion to facilitate the interaction between the two. The converse (viz., the child's behavior, including verbal and nonverbal components, is detected by the dentist, albeit at a subliminal level, and intercepted in appropriate interactive processes) is rationally more apparent, and there is some indirect evidence that such a process involves a learning curve (Paterson et al. 1980). There have not been any studies in the dental literature that have investigated children's recognition of facial expression as a function of age and sex.

The purpose of this study was to determine children's accuracy and latency to respond in a paradigm involving the recognition of facial expressions as a function of age and sex.

Methods

Subjects for this study consisted of three different groups of 20 children. The groups consisted of three year olds, six year olds, and nine year olds. Each group contained 10 boys and 10 girls. The subjects for this study were drawn from two elementary schools and one preschool program located in middle class, suburban communities in Columbus, Ohio.

The subjects were in good health and had no hearing or visual defects, learning disorders, or attention deficit disorders as determined by interviews with teachers and parents. The protocol of this study was approved by the Human Subjects Committee of The Ohio State University, and consent for participation was obtained from parents or legal guardians.

Slides of photographs of actor's faces depicting three different emotions (happiness, anger, and sadness) were obtained from a commercial source (Ekman P and Friesen WV: Pictures of facial affect. Palo Alto, CA: Consulting Psychologists' Press, 1976). The slides had been standardized and used in numerous studies. There were five different slides of each displayed emotion (as

posed by five different actors) for a total of 15 slides. The slides chosen were the five in each of the three categories (happy, sad, and angry) which had previously been shown to have the highest percentage of correct identification. The commercial source listed the percentage of correct responses for each slide from prior studies.

A slide projector equipped with tachistoscope was used to display the slides on a wide projector screen. The tachistoscope allowed the shutter of the projector to be open for a variable duration of time. The three different exposure times used in this study were 0.2, 0.5, and 1.0 sec. The tachistoscope was initiated manually, and when the tachistoscope was activated, a stopwatch was started simultaneously. The stopwatch was deactivated when the subject depressed a button on a response panel.

A custom-built response panel was used. The response panel consisted of a firm Styrofoam™ board with three evenly spaced pressure-activated switches attached. Below each button was a simplified facial drawing of each emotion (Fig 1, top right). This response panel was taped 6 in from the edge of the table at which each subject sat. Subjects were instructed to keep their hands flat on the table behind the panel until they responded. The edge of the table closest to the subject was 5 ft from the projector screen. Subjects were instructed to sit straight in the chair and as close to the table as possible. An assistant recorded the selected response and response time.

Three sets of slides, each containing the same 15 slides, were obtained. Three randomly selected orders of presentation of these slides were used. Each subject was placed randomly in one of three groups as determined by the order of the time settings used. Group A saw the first set of slides at 0.2 sec duration, the second at 1.0 sec, and the third at 0.5 sec. The order for Group B was 1.0, 0.5, and 0.2 sec, and the order for Group C was 0.5, 0.2, and 1.0 sec. Each slide projected was approximately 30 in high, 15 in wide, and 4 ft off the floor. The time period between tachistoscope activation and response constituted the latency of response. The accuracy of recognition between the projected slide and the subject's response was noted as correct or incorrect for each presentation.

Procedure

Each subject was briefed on the procedure and familiarized with the equipment. Each subject was asked to describe the three drawn faces in their own words. Each subject then was trained to a criteria for accuracy of response. For criterion establishment, slides of emotions (happy, sad, and angry) were shown to each subject until three consecutive slides were identified correctly. There was a time limit of 2 min for the projection of each slide while establishing criterion. Each subject was told to select the drawing which best matched the expression of the people in the slide within the 2 min period. The sequence of the projection of emotions was randomized for each subject at this time.

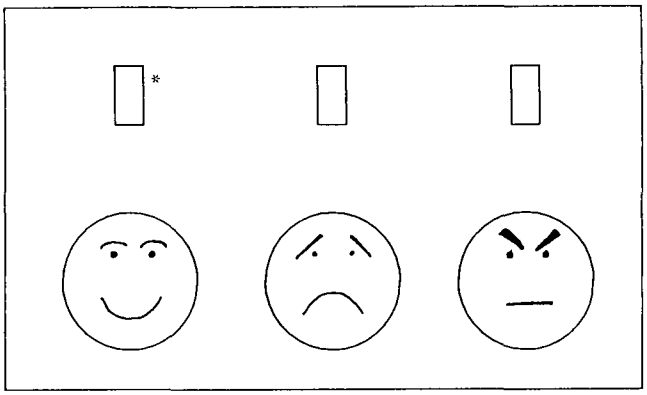

Fig 1. Response panel. * Represents switch.

Following criterion determination, the subject was instructed to watch the screen for slides that would be shown for short durations. After viewing the slide, the subject was told to press the matching button as quickly as possible. Each emotion was depicted by five different slides. There was a total of 55 exposures per subject.

To ensure that the subject was focused on the screen at the time of the presentation, the subject was asked to look at the screen. When the subject was oriented correctly, the tachistoscope was activated.

Several subjects were run through the procedure in a pilot study. This was done to familiarize all participating personnel with the procedure and to reduce the probability of timing error. The children learned the task readily.

The data was analyzed with a one-way analysis of variance in association with a Duncan multiple range test to determine if significant differences existed among groups on the measures of accuracy, sequence, and latency to respond. *t*-tests were used to determine significant differences in latency to respond to individual age and sex categories.

Results

The findings indicated that the three year olds on the average were significantly slower to respond to each of the three blocks of slides than either the six- or nine-year-olds ($f = 83.8$, $P < .01$; $f = 64.4$, $P < .01$; $f = 77.9$, $P < .01$, respectively). There was no significant difference for the latency to respond between the six- and nine-year-olds in blocks one and two; however, six year olds were significantly slower to respond for block three than nine year olds (Table 1, see next page).

Three year olds made significantly more mean number of errors in recognition of facial expressions of

TABLE 1. Mean Latency to Respond (Sec) to Facial Emotions of Three, Six, and Nine Year Olds

Block	3 yr.	6 yr.	9 yr.	f	P
1	4.19 ± 1.17	1.87 ± 0.36	1.44 ± 0.27	83.8	.000
2	3.77 1.12	1.80 0.38	1.40 0.31	64.4	.000
3	3.62 ± 0.22	1.75 ± 0.07	1.32 ± 0.06	77.9	.001

TABLE 2. Mean Number of Correct Recognitions (Per 15) of Facial Emotions of Three, Six and Nine Year Olds

Block	3 Yr.	6 Yr.	9 Yr.	f	P
1	11.05 ± 2.44	14.20 ± 1.11	13.60 ± 1.23	19.33	.001
2	10.95 3.47	13.95 1.32	13.85 2.03	9.72	.001
3	10.30 ± 3.31	14.55 ± 0.69	13.15 ± 2.25	17.05	.001

TABLE 3. Mean Latency to Respond (Sec) as a Function of Exposure Time of Facial Emotions of Three, Six, and Nine Year Olds

Time	3 Yr.	6 Yr.	9 Yr.	f	P
0.2	3.89 ± 1.02	1.72 ± 0.21	1.45 ± 0.31	89.7	.0001
0.5	3.82 1.14	1.85 0.41	1.34 0.28	64.9	.000
1.0	3.86 ± 1.19	1.83 ± 0.37	1.35 ± 0.24	65.3	.000

TABLE 4. Mean Number of Correct Recognition (Per 15) of Facial Emotions of Time of Three, Six and Nine Year Olds

Time	3 Yr.	6 Yr.	9 Yr.	f	P
0.2	10.6 ± 2.7	14.3 ± 1.0	13.8 ± 1.9	19.7	.001
0.5	10.2 3.5	13.9 1.4	13.1 2.0	12.5	.001
1.0	11.5 ± 2.9	14.5 ± 0.6	13.7 ± 1.7	11.8	.001

emotion for each of the three blocks of slides than either the six- or nine-year-olds ($f = 19.33$, $P < .001$; $f = 9.72$, $P < 001$; $f = 17.05$, $P < .001$, respectively). There was no significant difference for the mean number of errors committed in each of the three blocks of slides between the six- and nine-year-olds (Table 2).

When the data was grouped according to the time of exposure (viz., 0.2, 0.5, and 1.0 sec) of the slides, and the latency to respond and correct identification of the emotional expression was analyzed with one-way analysis of variance, statistically significant differences were noted. Consistently across time exposures, the three year olds had a longer latency to respond and made fewer correct responses (Tables 3 and 4). Although the 6 year olds were slightly slower to respond and made fewer errors than the 9 year olds, the difference was not significant.

An analysis of variance was done to determine significant differences among age groups for various substitution errors. Three year olds were found to incorrectly substitute happy for sad significantly more often than both the six- and nine-year-olds. Similar significant findings to that for the substitution of happy for sad occurred for the substitutions of happy for angry, sad for happy, angry for happy, and angry for sad. A comparison of six- and nine-year-olds showed no significant difference for this substitution.

There were no significant differences for the incorrect substitution of sad for angry among the age groups. Interestingly, it was noted that as a group, nine year olds made this error most often, followed by three year olds and finally six year olds.

Three year olds required significantly more trials to reach criterion than either the six- or nine-year-olds ($f = 5.17$, $P < .009$). There was no significant difference for the number of trials to reach criterion between the six- and nine-year-olds. The results also indicated that there was no significant affect of sex on any of the dependent variables.

The overall percentage of correct responses for the emotion of happiness was 91%. The overall percentage of correct responses for both sadness and anger was 84%. Three year olds scored 81% for the emotion happiness, 76% correct for anger, and 67% correct for sadness. Six year olds scored 99% correct for happiness and 93% correct for both sadness and anger. Nine year olds scored 93% correct for emotions of both happy and sad and 84% correct for anger.

Discussion

The main findings were that the three year olds had a significantly longer latency to respond and made significantly more errors of recognition than either the six- or nine-year-olds. This suggests that three year olds were less able to recognize and/or respond to facial expressions of emotions as compared to the other children. Although in general these findings support that of others (Odom and Lemond 1972; Zuckerman and Przewuzman 1979; Brosgole et al. 1983), some have found no difference as a function of age for children to label emotions (Stifter and Fox 1987). Differences in methodology, including stimulus characteristics and response modes, could account for the discrepancies among studies.

In this study several factors may have influenced the results. These may include a short attention span, decreased motivation to perform, and insufficient cognitive development in three year olds, leading to a decreased ability to grasp the experimental task in comparison to the older children. One may speculate that the process of perceiving an emotion, processing the information contained within the expressed emotion, and responding in an appropriate manner may have been overwhelming, or at least less efficient in the three year olds due to their developmental status. Supportive of this speculation was the fact that the three year olds required significantly more trials to reach criterion for

correct interpretation of displayed facies than did the six- and nine-year-olds.

The clinical implications of these findings are both fascinating and complex. For instance, this study may lead us to expect that on the average, younger children misinterpret expressed facial communications more often than older children. This is not an unreasonable assumption to follow. Moreover, either older or younger children may be impaired in their ability to understand facial communication in the context of a dental environment. A child who is emotionally upset does not cope well under a perceived stressful situation, and responds in a nonfacilitative social manner (e.g.: cries with tears and makes decreased eye contact with other individuals) may receive minimal amounts of information regarding the social interactive process regardless of their age. To further complicate matters, Davidoff (1986) has reported that several studies have shown that inverted faces are more difficult to interpret (i.e., when the child is lying in the dental chair with the operator sitting at the 12 o'clock position). Other interventions (e.g.: voice control, time-out, or HOM) usually are necessary to establish communication with the child.

Quite possibly, the combination (synergism) of voice control and facial expression may be expected to impact favorably in establishing communication with the child in a stressful environment, despite indications that the face provides more information than the voice under experimental conditions (Mehrabian and Ferris 1967). Certainly multimodal presentation of emotions tends to be identified more easily than information transmitted over a single modality (Burns and Beier 1973).

Three year olds made significantly more incorrect substitutions. The most frequent errors committed by three year olds were the incorrect substitution of happy and angry for sad. This finding agrees with that of Brosgole et al. (1983). In her study, three- to five-year-olds were shown pictures of happy, sad, and angry faces, but the children were required to point to the pictures that she verbally expressed. Again, three year olds had the most difficulty in identifying sad faces.

The incorrect substitution of sad for angry occurred similarly in each of the three age groups. In fact, the nine year olds made this error most often. It is possible that these emotions contain common negative aspects which confuse children. For example, both facial expressions of sad and angry have downturned corners of the mouth and altered eyebrow position. These features when viewed for brief periods of time, may have led to confusion in the interpretation of emotions. There is evidence that certain posed facies contain blends of emotions (Ekman et al. 1972), and this phenomenon may have influenced the results. It would be difficult to find blended emotions in happy and angry facies, and those emotions were the least confusing to the children in this study.

A learning effect may have occurred in this study in that the children may have learned to correctly identify emotions more frequently in later blocks of trials. This possibility was evaluated, and it was found that the nine- and three-year-olds did not exhibit any significant learning trends; however, the six year olds did improve in their third block of trials. This finding is difficult to interpret. Nonetheless, it was perceived that the six year olds appeared to be more motivated during the testing than were the other two groups. The nine year olds may have been bored with the procedure, whereas the three year olds simply may have been overwhelmed.

Conclusion

In summary, this study has shown that three year olds tend to perform more poorly, compared to six- and nine-year-olds, in identifying correctly facially expressed emotions as depicted in photographs. Furthermore, the three year olds responded with a longer latency and made more substitution errors than did the older children. Further study of the interaction of voice and facially expressed emotions seems warranted and clinically relevant.

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Sealant use increasing

Sealant use by pediatric dentists has increased substantially during the 1980s, according to a survey reported in the *Journal of Dentistry for Children*, July-August 1988.

This study surveyed pediatric dentists nationally to determine their level of sealant use and to examine the factors that affected level of use. Reasons cited for non-use included: preference for amalgams; cost-effectiveness of sealants versus amalgams; lack of insurance coverage; need for more research; lack of sealant efficacy; the possibility of sealing in decay; and patient resistance.

Nearly all the respondents to the survey stated that they had tried using sealants in private practice. More than half stated that they were either pleased or very pleased with their first sealant encounter, and 93.8 percent of the respondents stated that they were still using sealants.

Practitioners, overall, expressed a positive attitude toward sealant use. The majority (84 percent) believed that sufficient educational materials on pit-and-fissure sealants were available.

When asked about their preference for particular sealant physical properties, the majority (65.3 percent) preferred a visible light-cured system, followed by 30 percent who stated that they preferred an auto-polymerizing sealant material. Only one-fifth of the respondents stated that they were taught about sealants during undergraduate dental school. But the undergraduate sealant experience was not found to be associated with the respondent's current level of sealant use.

Conclusion

This study corroborated the increase in sealant use reported in a similar study conducted in 1985. While almost 70 percent of general dentists reported using sealants on at least some of their child patients, the percentage was 93.8 for pediatric dentists.

Pediatric dentists' knowledge about sealants was significantly more accurate and their attitudes toward sealants significantly more positive than the general dentists'.

Undergraduate and specialty training, journal articles, and scientific meetings were cited as the most frequent sources of information about sealants. Legality of delegation, insurance coverage, and patient acceptance were significantly associated with sealant use, so it was not surprising to find that non-users felt that additional research, insurance coverage, parental requests, and a change in state delegation laws might convince them to use sealants.