Stability and continuity in normal emotional development between infancy and early childhood: longitudinal research

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Abstract

In a longitudinal study, twenty subjects were introduced to twelve stimuli as infants (seven to thirteen months old) and twelve similar stimuli when they were preschoolers in early childhood (three through five years old). Video recordings were made of their emotional expressions and analyzed according to Parameters of Emotional Expression (PEEX) measuring latency, intensity, and duration of emotional expression. Overall latency measures suggest moderate levels of stability but no continuity. Overall duration measures suggest a lack of both stability and continuity. More research is needed to understand these varied results. Interestingly, intensity measures, while lacking stability, appear to be modulating between infancy and early childhood. Those with higher levels of intensity are moving toward lower levels of intensity and vice versa. These results are consistent with Thomas and Chess' "Goodness of Fit" model. Establishing normative data is useful in not only defining normal development but also in understanding deviations from normal development. This information, when coupled with future research, may help provide guidance to primary caregivers, professionals, and social policy makers.

Introduction

Emotional development consists of age-related changes in emotional reactions. Emotional reactions are expressed through behavior such as facial muscle movements, vocalizations, gestures and bodily postures. Important aspects of emotional development include descriptive research on how emotional expressions change with age, what is typical at different developmental periods, how individuals differ within the normal range, whether or not individuals show stability in emotional expression over time, and whether there is continuity or discontinuity in the development of emotional expression from one developmental period to another.

Information about normal emotional development is important because it may lead to identifying those individuals who are not developing normally, and are at risk for emotional disorders. One way of viewing psychopathology is that it is on a continuous dimension with

normal behavior. (1) From this view, what differentiates normal from abnormal behavior is a matter of degree or quantification. (2) Applying this approach to emotional development requires the description of normal emotional behavior in quantified terms at various periods of development. Once normal patterns of emotional behavior are described over time, early deviations from normal developmental pathways can be identified. This in turn will lead to early identification of children at risk for emotional disorders and possibly guide social policy for early interventions. According to Pollak, "it is clear that learning about emotions proceeds swiftly in nearly all children" (102), and learning may result in either normal or maladaptive patterns of emotional behavior. (3)

Maladaptive patterns develop over time and result from interactions between the child and environmental conditions. (4) The child brings individual differences based on heredity, such as temperament, to the interaction. Environmental conditions include social interactions with others. Developmental systems models explain how individual differences based on heredity (nature) and environmental experiences (nurture) interact over time to influence development. (5) According to Gottlieb's model there are different levels of activity, which influence each other over time. (6) For example genetic activity (first level) influences physiology (second level). Physiological activity, such as neural activity, influences behavior (third level). And behavior has an effect on the environment (fourth level). And each of these

influences is bidirectional. Therefore the environment can affect behavior, behavior can influence neural activity (level of physiology), and physiology can influence genetic activity.

Emotional expression is at the behavioral level. It is directly influenced by both physiology (such as neural activity) and the environment (such as social interactions). Because these influences are bidirectional, emotional expressions also influence social interactions. Emotional expressions function as a form of communication in social interactions. Emotional expressions are a way of communicating internal states, such as feelings, to others. (7) For example, when people feel happy, they smile. Communicating feelings and internal states to others is extremely important during infancy, since infants have not yet developed conventional language. (8) Internal states, such as hunger, and feelings, such as joy, are communicated to others through emotional expressions. These expressions give caregivers a clue about the infant's internal states and feelings. Emotional expressions are important in eliciting care-giving from adults during infancy. (9)

Descriptions of normal emotional expressions in infants are extensive. (10) However, the description of emotional expressions in normal children during early childhood is limited. (11) Furthermore, much of the research on emotional expression in infants and children in early childhood focuses on describing specific emotional expressions, such as joy, anger or fear, when they appear in development, and in what contexts they appear. More quantitative methods of evaluating normal emotional development are now needed to supplement the descriptive research. Emotional expressions described in terms of latency (reaction time), intensity and duration (length) has been more recent. (12) These parameters of emotional expression are a way of measuring any emotional expression to any stimulus in a quantitative manner. Since examining latency, intensity and duration of emotional expression is a new area of investigation, there is little information about what is typical at different developmental periods, such as infancy and early childhood. In an earlier investigation, normal infants' emotional expressions were described in terms of latency, intensity, and duration. (13) The current study investigated normal emotional development by quantitatively measuring latency, intensity and duration of emotional expression at infancy and early childhood. These measures begin to establish baselines for normal development at these points and provide insights into the issues related to stability and continuity of emotional expressions over time.

In addition, these parameters, latency, intensity and duration of emotional expression, are important because they reflect emotional processes, which are linked to underlying neurological processes. How neural mechanisms influence emotional expression can be explained by differential emotions theory. (14) Emotions involve underlying neural processes, specific motor expression, and corresponding subjective feeling. (15) Neural mechanisms are important in the activation of emotions and thereby influence the latency of emotional expressions. (16) Sensorimotor mechanisms are involved in the expression of emotions. (17) By innervating muscles, nerves influence the muscle movements in the face, as well as muscle movements that influence vocalizations, gestures and bodily postures. The number of movements involved in an expression can be viewed as a measure of the intensity of that expression. Certainly, neural mechanisms influence the length of muscle contractions, and thereby influence the duration of muscle movements. On the basis of differential emotions theory, neural mechanisms influence parameters of latency, intensity and duration of emotional expression. Based on the assumption that neural mechanisms influence these parameters, one of the goals of this research is to provide normative information on latency, intensity and duration of emotional expression during infancy and early childhood. "Surprisingly, little research has focused on the mechanisms underlying the emergence of emotional processes in children, and the neurodevelopmental processes involved in the organization of affective systems remain largely unknown" (Pollak, 103). (18) The description of latency, intensity and duration of emotional expression may be a beginning point in examining emotional processes and their underlying mechanisms.

In addition to providing quantitative descriptive information on emotional expression in a normal sample of children in early childhood, this study also analyzes similar information obtained from the same

participants during infancy and compares the two. Does an intense infant become an intense preschooler in early childhood? That is a question of stability. The question of whether or not individuals are stable in their emotional expression over time is addressed. While the concept of stability can be defined in various ways, the following definition was adopted for use in this study: lack of differences or only slight differences in traits or behaviors when measured within the same group of individuals in different periods of life. (19) In this study the same group of individuals was evaluated in terms of latency, intensity and duration of emotional expression during infancy and again during early childhood to examine whether or not individuals remain stable in their emotional expression. In addition to measuring overall stability, stability of specific emotional expressions, such as joy, anger or fear, was also examined in terms of latency, intensity and duration.

Understanding and measuring the continuity of emotional expressions over time is also important in establishing information on normal developmental pathways. Are infants very different in their emotional expressions from children in early childhood? If infants are not very different from children in early childhood, there is continuity in development. If infants are very different from children in early childhood, there is discontinuity in development. Discontinuity is indicative of stages in development. In this study, continuity or discontinuity in the expression of emotions from infancy to early childhood was investigated. Continuity in development was defined in terms of small increments of change that occur gradually over time. (20) Discontinuity in development was defined in terms of change that is more abrupt or noticeable, reflecting a qualitative change. (21) Analyzing the parameters of latency, intensity and duration of emotional expression from infancy to early childhood for signs of continuity or discontinuity would help us understand and measure stages in the expression of emotions from one developmental period to another. Continuity and discontinuity in the expression of specific emotions between infancy and early childhood was also examined.

The purpose of this research was to use the quantitative measures of latency, intensity and duration to provide baseline quantitative descriptions of emotional expressions in normal children during early childhood; and to analyze issues of stability and continuity in emotional expressions from infancy to early childhood. Both stability and continuity issues were analyzed overall, including all emotional responses to all stimuli. Additionally, stability and continuity issues were analyzed more specifically with regard to specific emotional expressions.

Method

Definitions

Emotion refers to a particular set of neural processes, specific motor expression, and corresponding subjective feeling. (22)

Basic emotions are emotions with innately determined neural substrates, a typical neuromuscular expressive pattern, and a distinct subjective feeling. Basic emotions include interest, joy, surprise, sadness, anger, fear, disgust, and contempt. (23)

Emotional expression refers to changes in facial and bodily movements, as well as in vocalizations, in response to a particular stimulus. (24)

Latency refers to the amount of time (in seconds) between the initial presentation of a stimulus and the beginning of an emotional expression on the face. (25)

Intensity refers to the magnitude of an emotional expression, including facial, vocal and bodily components that occur during the same time, as measured on an ordinal scale. (26)

Duration refers to the time (in seconds) between the onset and offset of facial expression. (27)

Stability refers to lack of differences or only slight differences in traits or behaviors when measured within the same group of individuals in different periods of life. (28) In this study it is measured in terms of correlations between infancy and early childhood in paired tests.

Continuity refers to small changes that occur gradually over time. (29) In this study it is measured in terms of lack of statistically significant differences between infancy and early childhood.

Discontinuity refers to changes that are more noticeable, reflecting a qualitative change. (30) In this study it is measured in terms of statistically significant differences between infancy and early childhood.

Participants

Participants were twenty children who had participated in similar research as infants and returned to participate during early childhood. Potential participants had been identified through birth announcements in the newspaper. Families were each mailed a letter informing them of the study and providing them with a phone number to call for more information. Parents interested in having their child participate in the study contacted the primary investigator by phone. The longitudinal sample consisted of twenty children, sixteen girls and four boys. The children were mostly Caucasian and of middle class income and education.

Developmental Screening

In order to assure that children were in the normal range of functioning for their age, screening devices were applied. In earlier research during infancy, APGAR scores had been obtained, with permission, from hospital records. Only infants with an APGAR score of seven or above, indicating good health were used in the final sample. Also during infancy, only infants who passed the Denver II, a pediatric screening tool for normal development, were used in the final sample. All children were given the Denver II again in early childhood. Only children who were functioning in the normal range were included in the final sample. Also, parents of children in early childhood were given the Child Behavior Checklist to complete. Only children who were in the normal range were included in the final sample. All twenty children in the longitudinal sample had passed all screening devices both during infancy and early childhood.

Procedures

Procedures were similar during infancy and early childhood. Parents interested in having their infant or child participate in the study contacted the primary investigator by phone. At that time, they were informed of the purpose and procedures of the research study. Those interested in participation made an appointment. At Salisbury University, the parent was greeted and given an information sheet. Any questions or concerns were addressed at that time. During infancy the parent was given a consent form, a release of medical information form (to obtain APGAR scores from hospital records), and a demographic questionnaire. When children came in during early childhood, the parent was given a consent form, the Child Behavior Checklist and a demographic questionnaire to complete. Both during infancy and early childhood, the Denver II was administered to the child by the primary investigator. The parent was present throughout the procedure.

The parent remained with the child in the room where videotaping occurred. A Panasonic AG-188U VHS camcorder was used for videotaping. The camcorder was connected to a time-code generator (SMPTE F-22) that encoded the time in minutes, seconds and frames (1/30 of a second) onto the videotapes. In order

to do so, the time-code generator was connected to a v.c.r., from which the tape actually recorded.

Both during infancy and early childhood, children's emotional expressions were videotaped for thirty seconds following the presentation of each stimulus. The stimuli elicited both positive and negative emotions. During early childhood, the following stimuli were used: 1) toy puppets, talking for thirty seconds, 2) a Halloween mask suddenly appears in the window for one second, 3) reciting a finger play (Eensy Weensy Spider) with child, 4) parent leaves room for thirty seconds, 5) while giving child a cookie it drops (child is given sticker instead), 6) a toy switch (toy carrot is put in hat and a rabbit puppet is pulled out, 7) an impossible puzzle (last piece does not fit), 8) an easy puzzle, 9) toy is taken from child, 10) child is given an empty box (wrapped like a present), 11) child is read a sad story, and 12) a loud noise (a key alarm sounds for two seconds). Each participant received a randomized order of the stimuli, with the exception that the Halloween mask was not one of the first four stimuli presented.

Similar, yet different stimuli had been used during infancy: 1) toy puppets talking for thirty seconds, 2) parent shows a still face (expressionless) for thirty seconds, 3) parent playing peek-a-boo for thirty seconds, 4) parent leaves the room for thirty seconds, 5) a stranger (student) approaches the child, 6) a toy switch (a different toy appears than was originally hidden), 7) a toy is placed just beyond reach, 8) infant is given a squeaky toy, 9) parent takes toy from child, 10) Winnie the Pooh pops up (three times), 11) a toy bug approaches child (three times), 12) a loud noise (a balloon pops only once).

Both during infancy and early childhood, parents were paid twenty dollars for their participation. Infants were given a pacifier to take home. During early childhood, children were given a toy to take home.

Measures

Parameters of Emotional Expression (PEEX) allows for coding facial expression, vocalizations and bodily movements for a range of basic emotions under a variety of stimulus conditions. The form allows for recording of times when facial expression appears, peaks, and disappears.

Latency was defined as the amount of time between the initial presentation of a stimulus and the onset of an emotional expression on the face. This time was determined by looking at the times encrypted on the videotape at the beginning of a stimulus presentation and the beginning of a facial expression. The time was encrypted onto the videotape using a time code generator during videotaping. The time is measured in minutes, seconds and frames (1/30 second).

Intensity referred to the magnitude of an expression. In this study the magnitude or intensity of an expression was examined in terms of three components: facial behavior, vocal behavior, and bodily postures or gestures. The time code in which the expression was at its peak or apex was used. The facial component of intensity was based on expression (muscle movements) in the three regions of the face: 1) brow, 2) eye/nose/cheek, and 3) mouth. Scores for facial intensity were dependent upon how many regions of the face were involved in an expression. For example, if only the mouth was involved in an expression, but the eyes and nose/cheek area were not involved, the facial intensity scored was "one." If all three regions of the face were involved in an expression, the facial intensity score was "three." In this study the magnitude of a facial expression was measured on a scale of zero to three, representing the three regions of the face involved in expression of emotions.

The vocal component of expression also ranged from zero to three, depending upon specific types of vocalizations that occurred during the peak facial expression (between the peak and offset of the peak). Vocal expression was measured on an ordinal scale (0-3) in terms of whether or not specific types of vocalizations occurred in a given time frame (between the peak and offset of the peak facial expression). Low level vocalizations involved whispering; these received an intensity score of "one." Moderate

vocalizations involved comments at a normal tone, as well as giggling, laughing, and crying. Those vocalizations, being louder, scored a "two." High intensity vocalizations involved loud vocalizations, such as loud crying, screaming, and squealing. High intensity vocalizations received a score of "three."

The bodily component of expression was based on whether or not specific gestures or body postures occurred during the peak facial expression. Examples of possible postures and gestures included: pointing to the stimulus, reaching for the stimulus, turning away from the stimulus, and putting the head in a downward position. Bodily expression was also measured on an ordinal scale (0-17) in terms of whether or not specific gestures occurred in a given time frame. While there were seventeen behaviors listed, actual scores ranged from zero to four, and an overwhelming majority of scores ranged from zero to three.

The total intensity score was a sum of facial, vocal and bodily components. While originally these were to be equally weighted, the data naturally fell in such a way that weighting these components was not necessary. Total intensity scores ranged from zero to nine. Both vocalizations and bodily postures were analyzed in the time frame between the peak of facial expression and the offset of the peak.

The duration of that emotional expression was defined as the time between the onset and offset of facial expression. The time was determined by looking at the time encrypted on the videotape for the beginning of an expression and the disappearance of that expression.

Reliability--For reliability assessment, each participant was coded by two independent raters using PEEX. Reliability was first measured by how well the two raters agreed on what facial expression of emotion was being exhibited by a particular participant to a particular stimulus. A Cronbach's alpha was computed for agreement on emotion by the two independent raters using the constructed scale. For the twenty longitudinal participants during infancy the alpha score for agreement on emotion by two independent raters was .747 for 240 observations (20 participants X 12 stimuli = 240 observations). For the same participants during early childhood the alpha score for agreement on emotion by two independent raters was .576 for 240 observations (20 participants X 12 stimuli = 240 observations).

Next, inter-rater reliability for intensity of expression was examined for PEEX. The total intensity score by each of the two raters for each participant for each stimulus was compared. The total intensity score was the sum of facial intensity (scale of 0-3), vocal intensity (scale of 0-3), and bodily intensity (scale of 0-17); although scores never ranged over 4). Again, a Cronbach's alpha was computed. During infancy, the alpha score for agreement on intensity of expression by two independent raters was .643 for 240 observations (20 participants X 12 stimuli = 240 observations). During early childhood the alpha score for agreement on intensity of expression by two independent raters was .720 for 240 observations (20 participants X 12 stimuli = 240 observations).

Coding

In order to become proficient in coding muscle movements in the face, students were first trained in using the Maximally Discriminative Facial Movement Coding System, MAX. (31) A training tape obtained from the author of MAX was used for this purpose. Students each had an initial two-hour training session with the instructor introducing them to MAX. Then students practiced coding with the use of the training tape. As instructed by the MAX manual, proficiency in coding was determined by a minimum of 80 percent agreement with the MAX training material codes. Once proficient in MAX codes, students received additional training in coding subjects using PEEX. Students were trained using a videotape of an actual participant who was not selected for the final sample.

Each participant was exposed to twelve stimuli during infancy and twelve stimuli during early childhood. Each of those observations was coded by two independent raters. After each observation was coded, the

specific emotion could be identified by examining combinations of muscle movements in the face, and looking up the combination of codes in the MAX manual supplement. (32) Only observations which had an emotional reaction were used in the statistical analysis.

Results

This study examined twenty longitudinal participants during infancy and again during early childhood. Only participants who had passed screening for normal development utilizing APGAR scores during infancy, the Child Behavior Checklist during early childhood and the Denver II both during infancy and during early childhood were included in the longitudinal sample. Both during infancy and early childhood participants were exposed to twelve different stimuli in a laboratory setting and their responses were video recorded. The stimuli used during early childhood were similar in general type as those used during infancy. Only those observations that resulted in a definable emotional expression were used in the statistical analysis. An individual overall average score for latency, intensity and duration of emotional expression was computed for each participant. The individual overall average score was based on emotional responses to twelve stimuli, combined without reference to the specific emotion exhibited. One of the objectives of this paper was to begin to develop specific quantitative information on normal emotional development for both infants and those in early childhood. This information can be useful in not only defining normal emotional development, but also in understanding deviations from normal development. Individual overall average scores for latency, intensity and duration of emotional expression during infancy and again during early childhood are provided in Table 1.

A second objective of this paper was to examine stability of emotional expression from infancy to early childhood. Stability was first analyzed in terms of individual overall stability. To examine whether individuals tend to remain stable from infancy to early childhood, individual overall average scores for latency, intensity and duration of expression (all stimuli combined) were calculated. The individual overall average latency during infancy was compared to the overall average latency during early childhood using correlations in paired samples tests. These correlations represent the degree to which individual responses within a group remain constant over time. The correlation for latency was somewhat moderate ($r = .381$, $p < .097$), indicating a certain degree of stability in latency from infancy to early childhood. The intensity of expression during infancy was compared to that of early childhood using the same technique. The correlation for intensity of expression was moderate, yet negative ($r = -.530$, $p < .016$). The negative correlation suggests that infants who were more intense in their expression became less intense in their expression, and infants who were less intense in their expression became more intense in their expression. The individual overall average duration of expression during infancy and early childhood was also compared. The correlation for duration of expression was weak ($r = -.223$, $p <.345$), indicating little or no stability in the duration of expression from infancy to early childhood.

In addition to examining individual overall stability, whether or not individuals are stable in their emotional expressions of specific emotions was examined. For this analysis individual scores were computed for average latency, intensity and duration for each specific emotion at both infancy and early childhood. The individual average latency for a specific emotion during infancy was compared to the individual average latency for that specific emotion during early childhood using correlations in paired samples tests. These correlations represent the degree to which individual responses within a group remain constant over time. Intensity and duration of specific emotional expressions were analyzed using the same technique. For the emotion of joy, the correlations for latency ($r = -.202$, $p < .407$) and duration ($r = .178$, $p < .466$) of emotional expression were relatively low. The correlation for intensity of expression for joy was moderate, yet negative ($r = -.481$, $p < .037$). The negative correlation indicates that those who were more intense in their expression of joy became less intense, and those who were not as intense in their expression of joy became more intense.

For the emotion of interest, correlations for latency ($r = .319$, $p < .228$) and intensity ($r = -.311$, $p < .242$) were fairly moderate, whereas the correlation for duration ($r = -.182$, $p < .501$) was lower. The negative correlation for intensity of expression implies that those who were low became higher and those who were higher became lower on intensity of expression. Overall, there appears to be little stability in the expression of joy and interest from infancy to early childhood as measured in terms of latency, intensity and duration of expression. There was not enough data to assess the emotions of surprise, fear, anger and sadness.

A third objective of this paper was to examine the level of continuity or discontinuity in the development of emotional expression from infancy to early childhood. Examining overall levels of continuity or discontinuity was based on individual overall average scores for latency, intensity and duration of emotional expression (all stimuli combined). Paired samples t tests were used to compare means from infancy to those of early childhood. The mean latency during infancy (for all infants) was significantly different ($t = -9.696$, $p < .0001$) from mean latency for all children during early childhood. Mean latency during infancy was 6.34 seconds (SD = 3.14), whereas mean latency during early childhood was 36.87 seconds (SD = 14.98). This significant difference in latency from infancy to early childhood suggests that there is discontinuity in latency of emotional expression between infancy and early childhood. This is evident in figure 1; each participants' individual average latency time at infancy and early childhood was plotted. Infants' latency times (in seconds) fall in a different range from the latency times of the same participants in early childhood. It is evident that latency times become significantly longer in early childhood.

While there appears to be discontinuity in latency of emotional expression, the results for intensity of expression showed continuity. The mean intensity of expression for all infants during infancy was not significantly different from the mean intensity of all children during early childhood ($t = .096$, $p < .924$), indicating high levels of continuity from infancy to early childhood. The mean intensity of expression during infancy was 3.38 (SD = .92) and the mean intensity during early childhood was 3.34 (SD = 1.04). This continuity is evident in figure 2; each participants' individual average intensity of expression score (in terms of behavior) was plotted for both infancy and early childhood. The range of intensity scores for emotional expression was mainly in the same range during both infancy and early childhood.

There was a significant difference in the mean duration of expression from infancy to early childhood ($t = -8.655$, $p < .0001$); again indicating discontinuity in development. The mean duration of emotional expression during infancy (for all infants) was 15.27 seconds (SD = 5.33) whereas the mean duration of emotional expression for all children during early childhood was 49.63 seconds (SD = 15.79). This discontinuity in development is evident in figure 3; each participants' individual average duration of expression (in seconds) was plotted both during infancy and early childhood. The duration of emotional expressions during infancy was mainly in a different range from the duration of emotional expressions in early childhood. It appears that emotional expressions are discontinuous and longer in duration during early childhood than during infancy. In summary, these results suggest that emotional expressions measured in terms of latency and duration are discontinuous from infancy to early childhood; whereas emotional expression measured in terms of intensity is continuous from infancy to early childhood.

Continuity in the expression of specific emotions from infancy to early childhood was examined by comparing the individual average latency, intensity, and duration of each specific emotion at those two times using paired samples t tests. There were significant differences in mean latency times between infancy and early childhood for joy ($t = -3.664$, $p < .002$) and interest ($t = -4.917$, $p < .0001$). This indicates there may be discontinuity in latency time for those emotions between infancy and early childhood. There were no significant differences in the means for intensity of joy ($t = .875$, $p < .393$) or interest ($t = -1.976$, $p < .067$) from infancy to early childhood. For duration of emotional expression there were significant differences between means during infancy and early childhood in the expression of joy (t

= -7.574, $p < .0001$) and in the expression of interest ($t = -4.131$, $p < .001$). These significant differences in the duration of expression point to discontinuity in the duration of the expressions of joy and interest.

Discussion

The purpose of this research was to provide quantitative baseline descriptions of emotional expressions in normal children during infancy and early childhood using the measures of latency, intensity and duration of emotional expression. It is also the purpose of this research to use the same measures to assess the overall stability and continuity of emotional expression (all stimuli combined), and to assess the stability and continuity of specific emotions.

Twenty participants were screened for normal development and observed during infancy and again during early childhood. On both occasions, participants came into the laboratory and were exposed to twelve different stimuli that were designed to be similar in both cases. Their emotional expressions in response to those stimuli were videotaped, coded, evaluated for reliability, and analyzed. Parameters of latency of emotional expression (from the onset of the stimuli to the onset of the emotional expression), intensity of emotional expression (facial, vocal and bodily behaviors) and duration of emotional expression (from onset of emotional expression to the offset of the emotional expression) were examined at infancy and again at early childhood and then compared.

One of the objectives of this paper was to begin to develop specific quantitative information on normal emotional development for both infants and those in early childhood. This information can be useful in not only defining normal emotional development but also useful in understanding deviations from normal development. This information, when coupled with future research, may help provide guidance to primary caregivers, professionals, and social policy makers. The baseline information for the latency, intensity, and duration of emotional expression at infancy and at early childhood is provided in Table 1. These scores represent an individual overall average score for each participant across all twelve stimuli. As can be seen from Table 1, the individual overall average latency during infancy ranged from 1.83 seconds to 14.07 seconds while the individual overall average latency during early childhood ranged from 13.10 seconds to 64.89 seconds. Individual overall average intensity of expression scores ranged from 1.90 to 5.67 at infancy and from 1.80 to 6.75 at early childhood. Individual overall average duration of expression during infancy ranged from 4.63 seconds to 24.01 seconds and ranged from 18.67 seconds to 78.63 seconds at early childhood. The duration of these expressions is longer than anticipated, based on other research. (33) The duration of emotional expressions, such as joy and interest, may have been influenced by the stimulus presentation, for example a thirty second puppet show or completing a puzzle. In general, however, the wide range of individual scores reflects significantly the wide range typically associated with individual differences. One of the challenges of future research will be to make sense of these differences and to develop models that signal when expressions are perceived to be outside of the normal range.

The second purpose of this study was to analyze aspects of stability and continuity of emotional expressions from infancy to early childhood. First individual overall measures of latency, intensity, and duration of emotional expressions were used to assess stability and continuity in development. Second, measures of latency, intensity and duration were used to assess the stability and continuity of specific emotions.

Individual overall stability was examined by comparing individual overall average latency, intensity and duration of emotional expression for each participant during infancy and early childhood. Correlations in paired tests were used to examine stability, i.e., whether individuals remain in the same place within their group or not. Strong correlations show that individuals maintain their same relative positions in the group over time and therefore are stable in their emotional expressions. Weak correlations suggest that

individuals are changing in how they express themselves as compared to others in the group and therefore are not stable with regard to those expressions.

In general, individual overall stability as measured by the parameter of latency revealed a moderate correlation. This indicates stability in latency of emotional expression from infancy to early childhood. The individual overall stability of latency across various stimulus conditions points to how individuals are the same in their reaction time from infancy to early childhood relative to others in the group. This suggests that individual differences in latency remain relatively stable from infancy to early childhood. Individual differences in latency may be influenced by underlying neurological processes. This is consistent with Differential Emotions Theory, which states that underlying neurological processes are important in the activation of emotions. (34) Furthermore, individual differences in sensory thresholds, an aspect of temperament, influence latency by the amount of stimulation that is necessary to initiate a response. Therefore, individual overall stability in latency of emotional expressions may be reflective of individual differences in temperament, especially in terms of sensory thresholds. This is consistent with Chess and Thomas' model of temperament. (35)

There appears to be a lack of stability when examining whether latency to emotional expression is stable for specific emotions. The correlations for the individual emotions of joy and interest were both weak suggesting a lack of stability. This apparent lack of stability in these specific emotions may be more reflective of how stimulus conditions influence latency of emotional expressions. Conversely, when all stimulus conditions are combined, and an average latency across all stimuli is calculated, more accurate reflections of individual differences in temperament across various situations are assessed.

Stability, when measured by the parameter of intensity showed a consistent lack of stability over all items measured. The significant overall negative correlation for intensity (all stimuli combined) of expression indicates a general lack of stability and suggests that infants who were more intense became less intense over time and infants who were less intense became more intense over time. Said another way, it appears that participants are moving more toward a central or common level of intensity. Interestingly, this phenomenon of negative correlations was not limited to stability as measured by the overall measure intensity of emotional expression (all twelve stimuli combined) but was also observed for the specific emotions of joy and interest.

One possible explanation for these results on intensity of expression is that emotional expressions become modulated over time. According to Chess and Thomas' "Goodness of Fit" model, there is an interaction between temperamental traits (such as the frequency of positive and negative emotional expressions, the intensity of emotional expressions, and sensory thresholds) and the environment (such as interactions with parents and others). (36) This interaction between temperamental traits and environmental experiences is a reciprocal one, so environmental experiences can influence the development of temperamental traits, such as emotional expression. Furthermore, Chess and Thomas' model is consistent with Gottlieb's developmental model in that environmental experiences, such as social interactions, influence behavior, such as emotional expressions, over time. Chess and Thomas' model appears to explain how infants with intense emotional expressions become less intense and infants who are less intense in their expression become more intense in their emotional expression.

Finally, stability, as measured by the parameter of duration, shows a consistent lack of stability across all items measured. Weak correlations were found for individual overall stability (all stimuli combined) between infancy and childhood, for the stability of the specific emotions of joy and interest. Further research on how underlying neurological processes influence the duration of emotional expressions or how stimulus conditions might influence duration of an emotional response is needed for explanation.

In addition to stability, continuity in emotional expressions from infancy to early childhood was analyzed.

Continuity of emotional expression was assessed by comparing participants' emotional responses to stimuli during infancy and again at early childhood. Results were analyzed utilizing paired t-tests. Continuity is considered to be high when responses during infancy are not significantly different from responses during early childhood. Conversely, discontinuity is considered to be high when subjects' responses during infancy differ significantly from those at early childhood. As with stability, continuity was evaluated in terms of latency, intensity, and duration of emotional responses to stimuli.

Whether or not emotional expressions are continuous or discontinuous overall was first assessed in terms of latency. Significant differences reflecting discontinuity were reported for overall latency (all stimuli combined) between infancy and early childhood. Similarly, when latency was examined for specific emotions, results again revealed high levels of discontinuity. Latency times during early childhood were significantly longer than latency times during infancy. It appears that children in early childhood process information longer than infants do before responding with an emotional expression. This longer latency may be indicative of more cognitive evaluation of the situation before responding. That would be consistent with children's increased cognitive abilities compared to that of infants. It would be interesting to investigate how both children's cognitive processes and emotional expressions change together between infancy and early childhood.

Examining the issue of continuity by measurements of intensity of expression provide interesting results. It was previously noted that, with respect to stability, all items measured using intensity showed a lack of stability. Interestingly, with respect to continuity, all items measured, i.e., overall intensity (all stimuli combined) and intensity of specific emotions, show high levels of continuity. What appears to be happening is that individuals with lower levels of intensity at infancy are showing higher levels of intensity at early childhood and visa versa (causing a lack of stability), but the net mean level of intensity at infancy is not significantly different from the net mean level of intensity at early childhood for any of the items measured. What this seems to indicate is that individuals modulate the intensity of their emotional expressions, but within a narrow range; the changes are small. This is consistent with Chess and Thomas' Goodness of Fit model, in which interactions with others modulate emotional expressions over time.

Similar to the results for latency, results for duration of emotional expression revealed high levels of discontinuity across all items measured. Significant differences were found between infancy and early childhood for overall duration (all stimuli combined), and for duration of specific emotions (joy and interest). This apparent discontinuity in the duration of emotional expressions between infancy and early childhood is intriguing. Possible influences on the duration of an emotional expression include underlying neurological processes as well as environmental experiences. Which one of these is more important in their influence is yet unknown.

Conclusions

Some quantitative baseline information on normal emotional development at infancy and during early childhood has been assembled and presented. Hopefully it will be useful in future research and in establishing normative information on emotional development that can help guide caregivers, professionals, and social policy makers.

Overall evaluations of stability and continuity of emotional expression can best be summarized by the measures of latency, intensity and duration used in this study. Latency measures suggest moderate levels of stability but no continuity. Duration measures suggest a lack of both stability and continuity. More research is needed to understand these varied results.

Interestingly, intensity measures suggest that emotional expressions for individuals are not stable but are

moving toward a common point. Participants with lower levels of intensity are becoming more intense and vice versa. One effect of this movement to a common point is the net mean level of intensity at infancy is not significantly different from the net mean level of intensity at early childhood; changes in intensity appear to be small and continuous. The results related to intensity appear to be consistent with Chess and Thomas' "Goodness of Fit" model.

When stability of emotional expression is measured in terms of overall latency (to all stimuli), individuals appear to remain relatively stable from infancy to early childhood. This supports Chess and Thomas' ideas about temperamental differences influencing emotional expressions.

Further support for the "Goodness of Fit" model comes from the data on how the intensity of expression modulates over time in small increments from infancy to early childhood. Continuity was observed in the intensity of emotional expression between infancy and early childhood. The discontinuities observed in terms of latency and duration of emotional expressions between infancy and early childhood require further investigation.

Mapping the developmental patterns of emotional expression during infancy and early childhood may help elucidate underlying processes. Information about normal emotional development is important because it leads to the identification of children who are at risk for emotional disorders. According to Chess and Thomas, both normal and pathological development is the result of an interaction between temperament and the environment over time. Goodness of fit describes the match between an individual's temperament and the environmental demands. (37) If the person's characteristics (such as intensity of emotional expressions) are adequate in mastering environmental demands, then there is goodness of fit. Goodness of fit leads to mastery over the situation, adaptive coping, and results in more positive developmental outcomes, such as normal emotional development. There is poorness of fit when an individual's characteristics result in maladaptive coping or a failure to adapt to environmental circumstances. This results in an unfavorable trajectory in terms of development, such as emotional disorder. This is consistent with the idea that abnormal emotional development is a deviation from normal emotional development along a dimension. Identifying those dimensions of emotional development is important in gaining insight into normal emotional developmental pathways, and deviations from them.

For this reason it is important to describe normal pathways in emotional development. Once those pathways are identified, early deviations from them can be further examined. The dimensions upon which emotional development can be quantitatively measured over time have yet to be identified. One possible approach is to examine the latency, intensity and duration of emotional expressions at various periods of development. Using these parameters may be a way of measuring and examining emotional expressions along various dimensions. How these parameters change over time and what factors influence changes in them may elucidate emotional processes yet unknown. According to Pollak, "Surprisingly, little research has focused on the mechanisms underlying the emergence of emotional processes in children, and the neurodevelopmental processes involved in the organization of affective systems remain largely unknown" (Pollak,103). (38) Only when underlying mechanisms of emotional development are understood can effective treatments or preventions be developed for children at risk for emotional disorder. "Treatments not directed at underlying mechanisms (of development) may address distal symptoms rather than the roots of mental illness in children" (Pollak, 108). (39)

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