**RESEARCH ARTICLE**

# Contagious Positive Affective Responses to Laughter in Infancy

Evan M. Jordan, M.S.*, David G Thomas, PhD

**Affiliations:**
Oklahoma State University, USA

*** Correspondence author:** Evan M. Jordan, M.S., Oklahoma State University, USA,
E-mail: evanmj@okstate.edu

**Abstract**

Emotional Contagion is the unconscious converging of one's emotional state with another, suggesting that one can "catch" the emotions of another through vocal, postural, and facial expressions (Hatfield et al., 1993). This phenomenon can be observed in infancy as early as the first 24 hours following birth. While negative emotional contagion has been studied in the form of contagious crying at various ages of infancy, positive emotional contagion has received very little attention. The purpose of the present study was to observe the emotional reactions of infants at 5 and 10 months of age when presented with a stimulus of their peers displaying positive affect. We hypothesized that infants would react to the stimuli of positive emotions with expressions of positive affect, including laughter. Additionally, we hypothesized that the intensity and duration of both the facial and vocal expressions would increase with age between assessments at 5 and 10 months. Results indicated that infants responded with positive emotions to the positive emotional stimuli more often than neutral stimuli, but emotional responsiveness did not increase between the two ages of assessment. This occurrence provides an initial platform for exploration of positive affect in infancy and its development into early childhood.

**Keywords**: infant, development, emotional contagion, empathy, positive emotions, laughter

**Word Count:** 9647

## Contagious Positive Affective Responses to Laughter in Infancy

The phenomenon of emotional contagion is characterized by the affective expressions of one individual evoking similar expressions and experiences in a perceiving individual (Dezecache, Jacob, Grezes, 2015; Hatfield, Cacioppo, & Rapson, 1993). Various theories and explanations of emotional contagion have been suggested, with the majority depicting it as an automatic response of imitation (Hatfield et al., 1993) involving the unintentional acquisition of another's mood-state (Hsee, Hatfield, Carlson, & Chemtob, 1990). In infants, emotional contagion is suggested to be a primitive form of empathy that is present prior to the development of more advanced forms that require a level of cognitive functioning not yet present (Thompson, 1987). However, research on the occurrence of emotional contagion in infancy is primarily limited to negative affect. Contagious crying, the reflexive crying response of an infant when exposed to the distressed cries of another infant, has been observed at various ages within the first year

 

following birth (Geangu, Benga, Stahl, & Striano, 2010; Martin & Clark, 1982; Sagi & Hoffman, 1976; Simner, 1971). In contrast, research that examines the emotional contagion of positive affect is minimal and confined only to its occurrence in adults (Brown, Brown, & Ramos, 1981; Chapman & Chapman, 1974; Provine, 1992), with research on infant emotional interactions with others focusing on imitative facial response (Meltzoff & Moore, 1989; Wormann, Holodynski, Karner & Keller, 2012) rather than the acquisition of the affect of another. Do infants have the capacity to "catch" positive emotions? Determining if positive affect is "contagious" during infancy will lead to greater insight into the concept of emotional contagion, and possibly, its role in the development of empathy in later life.

**Emotional Contagion**

According to Decety and Jackson (2004) there are three main components that define empathy, namely an emotional response to another individual's emotional state (often accompanied by the sharing of emotions with another), perspective taking, and self-other differentiation. The first of these components can be observed within the first hours of life in the form of contagious crying. Although contagious crying varies in frequency and intensity, it can be observed in infants as early as a few hours after birth. Simner (1971) examined the differences in emotional responding to different auditory stimuli of newborns of an average age of 70 hours. Findings demonstrated that infants responded with distressed cries significantly more when exposed to the distressed cries of infants compared to other auditory stimuli. Additionally, Sagi and Hoffman (1976) and Martin and Clark (1982) replicated the significant main effect in neonates of an average age of 34- and 18-hours old, respectively. These findings are indicative of the ability for infants to engage in contagious negative affective responses to the distressed cries of their peers. Consequently, Thompson (1987) and others theorize that emotional contagion in infancy is a primitive form of empathy that is present prior to, and upon which, the more advanced forms of empathy are built, which require a level of cognitive functioning not yet present infants.

Hoffman (2000) hypothesized that this contagious response would dissipate by approximately 6 months of age due to a learned increase in emotion regulation. However, Geangu and colleagues (2010) found that infants 1, 3, 6, and 9 months of age all exhibited similar levels of distress in response to infant crying as indicated by their vocal and facial expressions. In fact, infant participants responded more quickly with cry vocalizations at the age of 6 and 9 months when compared to the 3-month-old infants, indicating an increase, rather than a decrease in contagious emotional responding.

Sagi and Hoffman (1976) and Geangu and colleagues (2010) interpreted their findings in support of the theory that contagious crying had a strong relevance for empathy development. Specifically, Sagi and Hoffman supported contagious crying as being either an innate reaction or the result of simple learning mechanisms in early infancy that would provide a platform for the development of mature empathy. Geangu (2010) suggested mirror neurons as the system responsible for this crying behavior, a system implicated as the primary neural mechanism underlying empathy (Pfeifer, Iacoboni, Mazziotta, & Dapretto, 2008).

However, these findings regarding infant contagious crying must be examined with regard to two important criteria described by Campos and colleagues (2008): The first is that similarity between early- and later-appearing behaviors does not necessarily imply similarity in the processes or functions

 

of these behaviors. The second is that a behavior that is adaptive for a given developmental period may be of significance *only* for that period and have little relevance for later behaviors. Two examples of theoretical explanations of infant contagious crying that reflect these criteria are these: Simner (1971) theorizes that contagious crying is not relevant to empathy development, but rather a vocal imitation that offers infants auditory self-simulative feedback that establishes a basis for speech cue discrimination that develops at approximately 6 months of age. Alternatively, Campos and colleagues (2008) propose that these behaviors are indicative of competitive (rather than contagious) crying, with the distress vocalizations being a mechanism of resource competition to ensure that mothers nurse their offspring rather than someone else's. Overall, infants have been found to respond to the distressed cries of their peers with their own emotional responses of distress, but further research on the subject is needed to provide evidence that these early behaviors are indicative of later empathy.

**Differences in Emotional Development**

The present study was designed to take a step in the direction of examining emotional contagion in infants by going beyond contagious crying. Empathic behaviors including emotional contagion are often presented as being related to negative affect, rather than a response that occurs during both negatively and positively toned events (Martin & Clark, 1982; Simner, 1971). A response to the suffering or distress of another is characteristic of only one subtype of empathy known as empathic concern, which is thought to stem from reflexive responses to the distress of another individual (contagious crying). Empathic happiness, an alternative subtype of empathy, focuses on the positive emotions of individuals. The hypothalamic-pituitary-adrenal axis (HPA) and the sympathetic nervous system (SNS) are associated with both negatively- and positively-toned empathic responding, providing support for the theory that empathy encompasses both negative and positive emotions (Laurent, Ablow, & Measelle, 2012). Given that empathy encompasses the ability to share and feel both negative and positive emotions, we hypothesized that, if contagious crying is indeed a primitive form of empathy, then positive emotional contagion should occur in infants.

In searching for parallels between positive and negative emotional contagion, we must first recognize that there are underlying differences between the development of negative and positive emotions. While negative affect, including contagious crying, occurs within hours after birth, laughter does not appear until later in development. Additionally, positive emotionality tends to increase in both frequency and intensity throughout the development of the infant (Mireault et al., 2015; Rothbart, 1989; Sallquist, et al., 2010). The onset of the first forms of positive affect (smiling) do not typically occur in infants until 4 to 6 weeks after birth. Subsequently, laughter does not typically occur until approximately 4 months after birth (Sroufe & Waters, 1976). It is intuitively obvious that these developmental differences will influence the age at which infants' positive and negative emotional responsiveness to the emotions of their peers emerge. However, as their range of emotional behaviors increases, their propensity to use these behaviors in response to the emotions of their peers should also demonstrate an increase as is indicated by both the developmental trajectory of positive emotions (Mireault et al., 2015; Rothbart, 1989; Sallquist, et al., 2010) and the physiological processes that underscore both types of emotional events (Laurent, Ablow, & Measelle, 2012).

 

## Present Study

The present exploratory study stemmed from the theoretical position that (a) emotional contagion is a "building block" of empathy and (b) empathy encompasses both negative and positive affect. Therefore, if contagion is indicative of empathy, then positive emotional contagion should occur as well as negative emotional contagion in infancy. However, differences in the development of positive and negative emotions have been outlined above. These differences suggest that negative and positive emotional contagion are not parallel processes. The primary purpose of the present study was to determine whether the phenomenon of contagious laughter, or the contagion of any form of positive affect, is present in infancy in ways similar to contagious crying. This was achieved through the behavioral observation of infants, at 5 and 10 months of age, who were exposed to the audio and/or video presentation of laughter by other infants along with a control condition. Our first hypothesis was that infants would mimic the facial expressions and vocalizations that are displayed by the stimulus and would subsequently "catch" the emotion associated with those expressions, therefore converging emotionally with the stimulus. Furthermore, we hypothesized that a stimulus containing a visual social entity would elicit greater levels of positive affect when compared to an auditory-only stimulus. The majority of studies observing contagious crying in infancy used only audio for their crying stimuli (Martin & Clark, 1982; Sagi & Hoffman, 1976; Simner, 1971). However, the present study used both auditory and visual stimuli. The reasoning behind this alteration from previous studies is twofold. First, when trying to evoke laughter it is important to remember that it is a social process and generally requires the presence of another person (Provine, 2004). Second, by 5 months of age, infants are able to distinguish differences in vocal emotional expressions, but this occurs primarily when they are accompanied by a corresponding facial expression (Kahana-Kalman & Walker-Andrews, 2001). Secondly, we hypothesized that positive affective responding would increase between the ages of 5 and 10 months, as negative affective responding was found to in previous research (Geangu et al., 2010) and which is consistent with the research by Sallquist et al. (2010) and Sroufe and Waters (1976) that the ability to laugh and smile increases during development.

In an attempt to better understand the responses toward the emotionally charged stimulus, we also assessed negative affect and social referencing. Regarding the former, we predicted that infants would show less negative affect during the two laughter conditions compared to the control condition, thereby indirectly reinforcing our predicted response for positive emotion. Social referencing is the analysis of the emotional expressions of another individual, especially the primary caregiver (Hutman & Dapretto, 2009). Within the first year following birth, infants begin to examine the affective expressions of their mothers and use them as referents to aid in making decisions on how to respond emotionally (Mireault et al., 2014), especially novel situations (Feinman & Lewis, 1983). Our interest was whether social referencing increased from 5 to 10 months, subsequently influencing infant responses toward the stimulus.

## Method

### Participants

Full-term, healthy infants ($N$ = 42; 15 males and 27 females) and their mothers were observed. Participants were first assessed at the age of five months ($M$ = 22.71 weeks, $SD$ = 1.93) and again at 10 months of age ($M$ = 43.79 weeks, $SD$ = 1.52). Maternal ages

 

ranged between 24 and 40 years ($M$ = 30.54), with the majority of mothers being Caucasian (88%), married (90%), and college educated (86%). Three infants did not return for their 10-month appointment and the procedure was aborted for one participant at the 10-month appointment at the request of the mother due to excessive crying. After attrition, a final sample size for the 10-month assessment was 38 infants. Participants were recruited through flyers distributed across a university campus, local childcare facilities, and other infant/caregiver local organizations and received $5 travel compensation and a $25 gas card upon completion of the study.

## Materials and Procedure

Infants and primary caregivers visited the laboratory at both 5 and 10 months of age. Infants were placed in a seat and allowed to engage in free play for a minimum of 10 minutes or until the infant appeared to have acclimated to the laboratory environment. Acclimation to the environment was marked by a baseline behavioral state of a 2 or 3 as outlined by the AFFEX behavioral scaling system (Izard, Dougherty, & Hembree, 1983), indicating that the infant was alert/calm or alert/active, respectively. During the free play session, caregivers were instructed to engage in activities (e.g., peek-a-boo) that had previously elicited a positive emotional response in their infants. This was to ensure that the infant had the ability to display positive emotions prior to trying to elicit an emotional contagion response. Directly following the free play session, the 10-minute stimulus procedure began.

*Stimuli and procedure*. Infants were seated next to their primary caregivers in a chair facing a 71 cm (28-inch) video monitor 85 cm away to view the stimulus. The stimuli consisted of three separate conditions, each of which was 120 seconds in length. The first condition was audio-only, in which the screen appeared blank. The audio for this condition was composed of laughter clips of eight different infants of various ages within the first year of life. The majority were Caucasian, which matched the modal ethnicity for the sample. The second condition consisted of a compilation of both audio and video laughter. The audio from these videos was the same audio from the first condition presented in a different order, but was accompanied by their corresponding video. The final condition, the control condition, was comprised of eight clips of animated geometric patterns free of any social aspects that might have elicited emotional responses. A non-social control condition was chosen to determine a baseline of infant affect when exposed to a visual stimulus without social laughter. We wanted to provide a stimulus to parallel the white noise used in the original contagious crying study conducted by Simner (1971), and use a non-social, visual entity similar in neutrality to that white noise stimulus. Additionally, infants have been shown to smile and laugh in response to social situations (e.g., parents playing games); therefore, we wanted to ensure that the positive affect evoked in the infant was emotionally *contagious* rather than socially *responsive* positive emotion to social interactions (Jones & Raag, 1989). The implementation of a fourth condition displaying neutral social interactions was considered to allow for a comparison between potentially contagious and responsive emotion, however, in pilot research, we found that infants frequently became distressed toward the end of the three original conditions and extending the stimulus in length would have a negative effect on infant emotion. Finally, conditions were counterbalanced, creating a total of six different orders in which the stimuli were presented. A 2-minute break was taken between conditions. During this break, the primary caregivers were allowed to interact with their infants and sooth them if

 

necessary. If the infant showed signs of distress after the 2 minutes had passed, additional time was allotted to ensure that the infant had returned to a baseline mood before continuing with the next condition.

*Demographic questionnaire*. After the presentation of stimuli, the primary caregivers were administered a demographic questionnaire in order to collect general information regarding the infants and the members of their immediate families. Gender and age were recorded for each family member. Additionally, information on income level, marital status, number of siblings, and parental education level was gathered.

*AFFEX*. The coding of emotional contagion videos focused on both positive and negative affect. Total duration and peak intensity of emotional responses were recorded. Ratings of each emotional reaction were based on the AFFEX scaling system (Izard, Dougherty, & Hembree, 1983), but adapted to fit the current study. The AFFEX scaling system operationally defines five major emotional expressions including, anger, fear, sadness, joy, and interest. For the current study, anger, fear, and sadness were grouped to define negative emotional reactions, and joy and interest were grouped to define positive emotional reactions to the stimuli. The AFFEX system divides the face into three major regions, including the forehead/brow region, eyes/nose/cheeks region, and the mouth/lips/chin region, and details specific movements in each of these three segments. Based on facial movement in these divided regions, emotional responses were rated on a 5-point Likert scale with a rating of 1 indicating none of the facial regions showing codable movement and a rating of 5 indicating an overt emotional response of multiple facial regions showing codable movement. Duration of social referencing was also scored on this adapted scale with infants being assessed for the total number of seconds that they looked toward their mother's face across the three conditions.

## Results

Observation Oriented Modeling (OOM; Grice, 2011; Grice, Barrett, Schlimgen, & Abramson, 2012) was used to analyze the data. OOM compares the actual observations for each infant in each condition and at each age of assessment with expected patterns of outcomes and summarizes the results with accuracy indices. Depending on the statistical test, traditional null hypothesis statistical testing (NHST) relies on a variety of assumptions, such as homogeneity and normality of population distributions, whereas OOM utilizes randomization tests that are free of such assumptions. The data for this study violated the normality and homogeneity of treatment difference variances assumptions as many variables were skewed and the infants often did not respond emotionally to the stimuli, thus obtaining scores of zero. Because OOM is a non-parametric method, we were able to avoid the strict assumptions of NHST while also focusing more on the emotional responding of individual infants.

## Hypothesis 1

The hypothesis predicted that infants would mimic the facial expressions and vocalizations that are displayed in the laughing stimuli. We predicted that the audio-only condition would be sufficient in prompting a positive affective response similar in duration and intensity to the responses in the contagious crying studies. However, due to the fact that laughter and smiling (the latter being the most common positive emotional responses) are social in nature, it was expected that the audio-video condition would evoke responses of greater intensity and duration compared to the audio-only and control conditions. Therefore, we predicted that the audio-video

 

stimulus would elicit positive affect in a greater number of infants when compared to the audio-only and control conditions, and the audio-only condition would evoke positive affect in a greater number of infants when compared to the control condition. An *Ordinal Pattern Analysis* (Grice, Craig, & Abramson, 2015) in OOM was used to test these predictions.

Thus, for the *duration* of positive emotional responding to the conditions at 5 months of age, the expected ordinal pattern for each infant was audio-video > audio-only > control. Results indicated that only 6 of the 42 infants matched this pattern completely with respect to their duration scores. This frequency can be converted to a percentage (14.29%) which is referred to as the Percent Correct Classification (PCC) in an Ordinal Pattern Analysis. A simple randomization test can also be used to assign a probability statistic, referred to as a chance-value (or *c*-value), to the PCC. Based on 1000 random trials for duration, the *c*-value was .36, indicating that a PCC of at least 14.29% was improbable (i.e., there was a 36% chance that these numbers could be attained in 1000 randomization trials of the data) compared to randomized orderings of the original data and expected ordinal pattern. More specific comparisons showed, consistent with expectation, more infants demonstrating longer durations for the audio-only (PCC = 57.14, *c*-value = .03) and audio-video (PCC = 61.90, *c*-value = .01) conditions when compared to the control condition. Opposite of expectation, however, slightly more infants showed longer durations of positive responding for the audio-only condition compared to the audio-visual condition (PCC = 52.38, *c*-value = .15).

The PCC values above indicate percentages based on the full sample size. However, of the 42 infants, five did not respond emotionally at all to the control and audio-only conditions (i.e. they obtained a score of zero for each condition being compared), five infants did not respond emotionally to the control and audio-video conditions, and four infants did not respond to the audio-only and audio-video conditions. Of the emotionally responsive infants, 24 of 37 infants demonstrated an increase in duration between the control and audio-only conditions (PCC = 64.86, *c*-value = .04), 26 of 37 infants between the control and audio-video conditions (PCC = 70.27, *c*-value < .01), but only 15 of 38 showed an increase from audio-only to the audio-video condition (PCC=39.47, *c*-value = .92).

With regard to the *intensity* of positive emotional responding across the three conditions at 5 months, the overall ordinal pattern (viz., audio-video > audio-only > control) was again first examined. Results indicated that only 5 of the 42 infants (PCC = 11.90, *c*-value = .47) matched this expected pattern. Specific ordinal comparisons showed a greater number of infants with higher emotional responding for the audio-only (PCC = 61.90, *c*-value = .01) and audio-video (PCC = 61.90, *c*-value < .01) conditions compared to the control condition. Once again, inconsistent with the hypothesis, the audio-video condition did not yield greater emotional intensity compared to the audio-only (PCC = 35.71, *c*-value = .80).

After removing the emotionally unresponsive infants, 26 of 37 infants demonstrated an increase in emotional intensity between the control and audio-only conditions (PCC = 70.27, *c*-value = .01), 26 of 37 infants between the control and audio-video conditions (PCC = 70.27, *c*-value = .01), but only 15 of 38 showed an increase from audio-only to audio-video conditions (PCC = 38.47, *c*-value = .80).

An identical set of Ordinal Pattern Analyses were conducted on the infants' 10-month data. Results indicated that only 5 of the 38 infants (PCC = 13.16, *c*-value = .28) matched this pattern completely with respect

 

to their duration scores. Once again, specific comparisons were consistent with the original hypothesis in that a majority of infants demonstrated longer durations for the audio-video (PCC = 52.63, *c*-value = .09) and the audio-only (PCC = 52.63, *c*-value = .08) when compared to the control condition. However, inconsistent with the original hypothesis, fewer than half of the infants in the audio-video condition yielded longer durations compared to the audio-only condition (PCC = 41.03, *c*-value = .66).

Of the 38 infants, six did not respond emotionally at all to the control and audio-only conditions, seven infants did not respond emotionally to the control and audio-video conditions, and two infants did not respond to the audio-only and audio-video conditions. Of the emotionally responsive infants, 20 of 32 demonstrated an increase between the control and audio-only conditions (PCC = 62.50, *c*-value = .06), 20 of 33 between the control and audio-video conditions (PCC = 60.61, *c*-value = .08), but again only 16 of 37 showed an increase from audio-only to audio-video conditions (PCC = 43.24, *c*-value = .65).

With regard to *intensity* of positive emotional responding at 10 months of age, results indicated that only 6 of the 38 infants (PCC = 15.79, *c*-value = .12) matched this pattern completely with respect to their intensity scores. Specific comparisons were not consistent with the original hypothesis in that a *minority* of infants demonstrated increased intensity for the audio-only (PCC = 39.47, *c*-value = .47) and the audio-video (PCC = 47.37, *c*-value = .30) when compared to the control condition. Additionally, only a *minority* of infants demonstrated greater intensity in the audio-video condition compared to the audio-only condition (PCC = 46.15, *c*-value = .25), which was once again inconsistent with the original hypothesis.

Of the emotionally responsive infants, 15 of 31 demonstrated an increase between the control and audio-only conditions (PCC = 48.39, *c*-value = .52), 18 of 33 infants increased in intensity between the control and audio-video conditions (PCC = 54.55, *c*-value = .30), and 18 of 36 showed an increase from audio-only to the audio-video condition (PCC = 50.00, *c*-value = .25).

In summary, the data (see Table 1) for both the 5- and 10-month assessment did not follow the originally predicted pattern (audio-video > audio-only > control). However, paired comparisons indicated that positive emotional responding was elicited more often in infants by the two emotionally charged conditions when each was compared to the control condition. This was true for both duration and intensity at 5 months as well as when non-responsive infants were included or not. However, at 10 months duration values were marginal and intensity values were equivocal; removing non-responsive infants did little to influence these results. Additionally, it was found that for the majority of infants the audio-only condition elicited emotional responses of longer duration and greater intensity compared to the audio-video condition. Overall, a majority of infants responded with positive emotions to either the audio-only or the audio-video condition at 5, but not 10 months.

 

**Table 1**

*Ordinal Pattern Analysis for Measures of Positive Emotional Responding at 5 and 10 Months*

| | *Duration* | | | *Intensity* | | |
|---|---|---|---|---|---|---|
| *Ordinal Pattern Tested* | *n* | PCC | *c*-value | *n* | PCC | *c*-value |
| ***5 Month*** | | | | | | |
| audio-video > audio-only > control | 6 | 14.29 | .36 | 5 | 11.90 | .47 |
| audio-only > control | 24 | 57.14 | .03 | 26 | 61.90 | .01 |
| audio-video > control | 26 | 61.90 | .01 | 26 | 61.90 | .01 |
| audio-video > audio-only | 22 | 52.38 | .15 | 15 | 35.71 | .80 |
| ***10 Month*** | | | | | | |
| audio-video > audio-only > control | 5 | 13.16 | .28 | 6 | 15.79 | .12 |
| audio-only > control | 20 | 52.63 | .08 | 15 | 39.47 | .47 |
| audio-video > control | 20 | 52.63 | .09 | 18 | 47.37 | .30 |
| audio-video > audio-only | 16 | 41.03 | .66 | 18 | 46.15 | .25 |

*Note*. 5-month data were complete for 42 infants; 10-month data were complete for only 38 infants.

**Hypothesis 2**

Hypothesis 2 predicted that infants would show more positive affect (measured by intensity and duration) in both the audio-video and audio-only conditions, respectively, when observed at 10 months compared to 5 months of age. In order to test this hypothesis an Ordinal Pattern Analysis was conducted to determine the effect of age on the duration of positive emotional responses between the ages of 5 and 10 months of age. With regard to increases in *duration* of positive emotional responding across ages, the results indicated that the pattern was correctly matched by only 17 infants (PCC = 44.74, *c*-value = .23) in the control condition, and 19 infants (PCC = 48.72, *c*-value = .36) in the audio-only condition. However, 22 infants (PCC = 56.41, *c*-value = .14) showed longer durations of positive affect at 10 vs. 5 months.

Regarding *intensity* of positive emotional responding in the 42 infants, none of the patterns support our original hypothesis, in that only a *minority* of infants demonstrated an increase in positive emotional responding between the two ages. Specifically, the pattern was matched correctly by 18 infants (PCC = 47.37, *c*-value = .29) in the control condition and the audio-video condition (PCC = 47.37, *c*-value = .55), and only 13 infants in the audio-only condition (PCC = 33.33, *c*-value = .95). The Positive Emotion segment of Table 2 summarizes these results.

 

**Table 2**

*Ordinal Pattern Analysis for Measures of Positive and Negative Emotional Responding & Referencing Across Ages*

| | *Duration* | | | *Intensity* | | |
|---|---|---|---|---|---|---|
| *Ordinal Pattern Tested* | *n* | PCC | *c*-value | *n* | PCC | *c*-value |
| ***Positive Emotion*** | | | | | | |
| Control | 17 | 44.74 | .23 | 18 | 47.37 | .29 |
| Audio-Only | 19 | 48.72 | .36 | 18 | 47.37 | .55 |
| Audio Video | 22 | 56.41 | .14 | 13 | 33.33 | .95 |
| ***Negative Emotions*** | | | | | | |
| Control | 14 | 36.84 | .70 | 12 | 31.58 | .89 |
| Audio-Only | 8 | 20.51 | .99 | 8 | 20.51 | .99 |
| Audio Video | 8 | 20.51 | .94 | 8 | 20.51 | .89 |
| ***Infant Referencing*** | | | | | | |
| Control | 38 | 65.79 | .01 | -- | -- | -- |
| Audio-Only | 39 | 66.67 | .01 | -- | -- | -- |
| Audio Video | 39 | 66.67 | .01 | -- | -- | -- |

*Note*. 5-month data were complete for 42 infants; 10-month data were complete for only 38 infants; referencing scores are only measured in duration and are complete for only 39 infants; PCC represents change from 5 to 10 months; expected ordinal pattern for positive emotion and infant referencing was 10 months > 5 months; expected ordinal pattern for negative emotion was 5 months > 10 months

## Hypothesis 3

**Negative emotional responding**. In order to determine if the positive emotional stimuli affected the intensity and duration of negative emotional responding, sets of Ordinal Pattern Analyses similar to those above were conducted. The expected ordinal pattern for the duration and intensity of negative emotional responding was as follows: control > audio-only > audio-video.

Similar to the findings for positive emotional responding, only 5 of the 42 infants (PCC = 11.90, *c*-value = .14) matched this pattern completely with respect to their negative responding duration scores at 5 months of age. More specific comparisons showed that, inconsistent with expectations, a *minority* of infants demonstrated shorter durations of negative emotional responding toward the audio-only (PCC = 45.24, *c*-value = .02) and audio-video (PCC = 45.24, *c*-value = .01) conditions compared to the control condition, and only a *minority* of infants had shorter durations of negative emotional responding toward the audio-video condition compared to the audio-only condition (PCC = 23.81, *c*-value = .73).

Similar to the positive emotional responding, the PCC values above indicate percentages

 

based on the full sample size. However, of the 42 infants, 14 did not respond with negative affect at all to the control and audio-only conditions, 14 infants did not respond negatively to the control and audio-video conditions, and 19 infants did not respond negatively to the audio-only and audio-video conditions. Of the emotionally responsive infants, 19 of 28 demonstrated a decrease between the control and audio-only conditions (PCC = 67.86, *c*-value = .03), 19 of 28 between the control and audio-video conditions (PCC = 67.86, *c*-value = .01), and 10 of 23 showed a decrease from audio-only to audio-video conditions (PCC = 43.48, *c*-value = .73).

With regard to the *intensity* of positive emotional responding across the three conditions at 5 months, the overall ordinal pattern (viz., audio-video < audio-only < control) was again first examined. Results indicated that, once again, only 5 of the 42 infants (PCC = 11.90, *c*-value = .06) matched the pattern completely. Specific comparisons indicated that, inconsistent with expectations and similar to the duration analysis, a *minority* of infants demonstrated reduced levels of intensity of negative emotional responses toward the audio-only (PCC = 42.86, *c*-value = .04) and audio-video (PCC = 42.86, *c*-value = .02) conditions compared to the control condition, and only a *minority* of infants demonstrated reduced intensity to the audio-video condition compared to the audio-only condition (PCC = 23.81, *c*-value = .58).

After removing the emotionally unresponsive infants, 18 of 28 demonstrated a decrease between the control and audio-only conditions (PCC = 64.29, *c*-value = .05), 18 of 28 between the control and audio-video conditions (PCC = 64.29, *c*-value = .02), and 10 of 23 showed a decrease from audio-only to audio-video conditions (PCC = 43.48, *c*-value = .58).

An identical set of Ordinal Pattern Analyses were conducted on the infants' 10-month data. Results indicated that only 6 of the 38 infants (PCC = 15.79, *c*-value = .18) matched this pattern completely with respect to their duration scores. Once again, specific comparisons examining the entire sample were inconsistent with the original hypothesis in that a *minority* of infants were found to have shorter durations of negative emotional responding for the audio-only (PCC = 36.84, *c*-value = .72) and the audio-video (PCC = 47.37, *c*-value = .06) when compared to the control condition. Additionally, a *majority* of infants showed shorter durations of negative emotional responding in the audio-video condition compared to the audio-only condition (PCC = 51.28, *c*-value = .04).

Of the 38 infants, eight infants did not respond emotionally at all to the control and audio-only conditions, 11 infants did not respond emotionally to the control and audio-video conditions, and 10 infants did not respond to the audio-only and audio-video conditions. Of the emotionally responsive infants, only 14 of 30 demonstrated the predicted decrease between the control and audio-only conditions (PCC = 46.67, *c*-value = .70), but 18 of 27 infants did show this decrease between the control and audio-video conditions (PCC = 66.67, *c*-value = .02); 20 of 29 showed a decrease from audio-only to audio-video conditions (PCC = 68.97, *c*-value = .02).

With regard to intensity of negative emotional responding at 10-months, results indicated that once again only 6 of the 38 infants (PCC = 15.79, *c*-value = .13) matched the pattern completely. More specific comparisons indicated that only 42.11% of infants demonstrated reduced levels of intensity toward the audio-only (PCC = 42.11, *c*-value = .42) compared to the control condition and 44.74% of infants demonstrated reduced levels of intensity

 

toward the audio-video stimulus (PCC = 44.74, *c*-value = .09) compared to the control condition. Furthermore, only a *minority* of infants (PCC = 48.72, *c*-value = .04) showed reduced levels of intensity between the audio-only and audio-video conditions.

Of the emotionally responsive infants, 16 of 30 demonstrated a decrease between the control and audio-only conditions (PCC = 53.33, *c*-value = .46), 17 of 27 infants between the control and audio-video conditions (PCC = 62.96, *c*-value = .07), and 19 of 29 showed a decrease from audio-only to audio-video conditions (PCC = 65.52, *c*-value = .06).

These results (Table 3) indicate that infants did not follow the originally predicted pattern of decreasing negative emotions across conditions for either the 5- or 10-month assessments (audio-video < audio-only < control) when the entire sample was considered. The most frequent pattern in both the 5- and 10-month data indicated increased negative emotional responding in the emotionally charged conditions compared to the control condition. This is not to say that the emotionally charged conditions definitively caused infants to respond negatively, but that these infants may not have experienced negative emotion in either the control or the emotional charged conditions. In fact, when emotionally non-responsive infants were excluded from the analyses, the originally expected effect emerged in that negative emotional responding was reduced in the two experimental conditions. However, as with the analyses of positive affect, these effects were evident at 5 months but became less robust at 10 months.

**Table 3**

*Ordinal Pattern Analysis for Measures of Negative Emotional Responding at 5 and 10 Months*

| | *Duration* | | | *Intensity* | | |
|---|---|---|---|---|---|---|
| *Ordinal Pattern Tested* | *n* | PCC | *c*-value | *n* | PCC | *c*-value |
| ***5 Month*** | | | | | | |
| control > audio-only > audio-video | 5 | 11.90 | .14 | 5 | 11.90 | .06 |
| control > audio-only | 19 | 45.24 | .02 | 18 | 42.86 | .04 |
| control > audio-video | 19 | 45.24 | .01 | 18 | 42.86 | .02 |
| audio-only > audio-video | 10 | 23.81 | .73 | 10 | 23.81 | .58 |
| ***10 Month*** | | | | | | |
| control > audio-only > audio-video | 6 | 15.79 | .18 | 6 | 15.79 | .13 |
| control > audio-only | 14 | 36.84 | .72 | 16 | 42.11 | .42 |
| control > audio-video | 18 | 47.37 | .06 | 17 | 44.74 | .09 |
| audio-only > audio-video | 20 | 51.28 | .04 | 19 | 48.72 | .04 |

*Note*. 5-month data were complete for 42 infants; 10-month data were complete for only 38 infants.

 

**Negative emotional responding from 5 to 10 months**. Ordinal pattern analyses were conducted to determine if negative emotional responding would decrease between 5 and 10 months. With regard to changes in *duration* of negative emotional responding across ages, the results indicated that the pattern (5 months > 10 months) was correctly matched by only 14 of 39 infants (PCC = 36.84, *c*-value = .70) in the control condition, 8 infants (PCC = 20.51, *c*-value <.01) in the audio-only condition, and 8 infants (PCC = 20.51, *c*-value = .94) in the audio-video condition.

Additionally, an ordinal pattern analysis was conducted to determine if the *intensity* of negative emotional responding would decrease between ages in the 38-infant sample. Results did not support our original hypothesis, in that only a *minority* of infants demonstrated a decrease in negative emotional responding between the two ages. Specifically, the pattern was matched correctly by 12 infants (PCC = 31.58, *c*-value = .89) in the control condition, 8 infants (PCC = 20.51, *c*-value = 1.00) in the audio-only condition, and 8 infants in the audio-video condition (PCC = 20.51, *c*-value = .89) These results indicate that negative emotional responding does not decrease between the two ages of assessment in these infants. (See Negative Emotions segment of Table 2)

**Infant social referencing**. To better understand general changes in emotional responding between the ages of 5 and 10 months, ordinal pattern analyses were conducted to determine the effects of age on infant referencing between 5 and 10 months. Results (Infant Referencing segment of Table 2) indicated that approximately two-thirds of the infants demonstrated an increase in referencing between the two ages for all three conditions: the control condition (PCC = 65.79, *c*-value = .01), the audio-only condition (PCC = 66.67, *c*-value = .01) and the audio-video condition (PCC = 66.67, *c*-value = .01). These results indicate that the number of infants who referenced their mothers was found to increase in all three conditions between the two ages of assessment.

## Discussion

### Hypothesis 1

The primary aim of this study (Hypothesis 1) was to examine whether positive emotional contagion occurs in infants and if it can be produced using similar methods to those implemented in contagious crying studies (Geangu et al., 2010; Martin & Clark, 1982; Simner, 1971). At 5 months of age, significantly (i.e., *c*-values < or = .05) more infants were found to display positive emotional responses of greater intensity and longer duration in the emotionally charged conditions compared to the control condition; the audio-only condition also evoked positive affect of greater intensity and longer duration in a greater number of infants than the control condition, but these differences were only marginal as just over half of the infants fit this specific comparison pattern with regard to duration, although these differences were more robust for measures of intensity. Nevertheless, this was not in keeping with the second part of Hypothesis 1, which predicted that more infants would show greater intensity and duration of positive emotional responses in the audio-video condition due to the inclusion of visual images of infant peers. Further analysis indicated that when emotionally unresponsive infants were excluded from the analyses, these results became more robust. By 10 months of age, positive emotional responding was still present, but had diminished to just above half of the infants for measures of duration and below 50% for measures of intensity. When the emotionally unresponsive infants were removed from the analyses, these percentages of duration became more robust,

 

although probabilities (*c*-values) remained above .05.

With regard to the effects found in the 5-month assessment, it is plausible that infants were capable of converging emotionally with their peers when provided with an emotionally charged stimulus. However, the audio-video condition may have been too stimulating to actually produce a greater amount of positive emotion in more infants than the audio-only condition, but maintained the infants' overall attention. Television programs aimed at infants and toddlers generally implement rapid changes in both images and sound that are interesting to infant/toddler viewers, but can ultimately overstimulate their senses (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004). The use of several combined video clips created a similar rapidity of images and sound changes that may have also contributed to the over-stimulation of the infants and the reduced effects in the audio-video condition compared to the audio-only condition.

Additionally, it has been found that when trying to elicit laugher and social smiling in infants, the effective elicitors proceed from intrusive tactile and auditory information (tickling, loud and abrupt vocalizations by primary caregivers) to visual social events across the first year of life with 12-month-old infants responding more frequently to visual social events than younger infants (Sroufe & Waters, 1976). This does not necessarily explain the diminished effect at 10 months, but could provide supporting evidence as to why the 5-month-old infants responded with greater intensity and longer duration to the audio-only condition (auditory information) compared to the audio-video condition (visual social events).

While positive emotional responding did occur during these assessments, overt laughter was only observed on some occasions (<1% of possible intensity coding occasions). This is not consistent with the robust findings of the contagious crying studies that provided a basis for the current exploratory study (Geangu et al., 2010; Martin & Clark, 1982; Simner, 1971). Therefore, while our results do not rule out the notion that emotional contagion is a building block of more mature forms of empathy, it appears that positive emotional contagion is not as easily produced by emotional displays by peers as is negative emotional contagion by the distressed cries of peers.

**Hypothesis 2**

Hypothesis 2 predicted that positive emotional contagion would increase in both intensity and duration between 5 and 10 months. As negative emotional contagion has been theorized to be a building block of more mature forms of empathy (Hatfield et al., 1993) it can be subsequently theorized that if emotional contagion is a more primitive form of the empathy that develops later in life, it should strengthen across the course of development. Such is the case for positive emotionality in general, which is found to increase in both frequency and intensity throughout the development of the infant (Rothbart, 1989; Sallquist, et al., 2010). Additionally, by 10 months, infants are usually locomotive, which has been found to trigger perceptual and emotional changes and increase the need for emotional communication (Anderson, et al., 2013; Campos et al., 2000). Regardless, there was not an effect of age on the intensity or duration of positive emotional responding to the positively charged conditions in the stimulus. Furthermore, there was an increase in the number of unresponsive infants at 10 months (compared to the 5-month assessment). One possible explanation is that by 10 months of age infants have been laughing for an average of 6 months (Sroufe & Waters, 1976) and the minimal social interaction provided by the audio-only and

audio-video recordings may have been insufficient to produce an emotional response or convergence with the stimuli.

Another possible explanation to the modest effect in the audio-video condition between the two ages is habituation to television by 10 months of age. A study by Zimmerman, Christakis, and Meltzoff (2007) observing the television viewing patterns of infants between 2 and 24 months found that nearly 40% of infants began watching television by the time they were 3 months of age and that the amount of time they spent watching increased with age. As infants are exposed to a stimulus repeatedly, their attunement to the stimulus decreases (Turk-Browne, Scholl, & Chun, 2008). While the infant participants in this study would not have habituated to this specific set of visual stimuli, it is possible that increased television watching had habituated the infants to the novelty of rapidly changing auditory and visual stimuli.

Finally, as infants gain locomotor capabilities they begin to explore their world and increase the distance between themselves and their primary caregivers while doing so. As infants are exploring novel situations, they will engage in social referencing with their caregivers and use the emotional responses from the caregivers to make inferences about their actions and their own emotional responses. However, lack of emotional response by caregivers while being referenced by their infants also affects the willingness of infants to explore novel situations. Sorce and Emde (1981) found that when mothers were emotionally unresponsive to a situation and did not attend to their 15-month-old infants, their infants were less likely to explore new situations, stayed closer in proximity to their mothers, and were less active overall than infants whose mothers emotionally attended to the situation. In the current study, mothers were instructed to maintain a neutral expression and avoid looking at their infants when the infants attempted to reference them. It is possible that by the 10-month assessment, the infants' tendency to respond positively to the stimulus was affected by the unresponsiveness of the caregivers. Further support for this explanation can be found in a recent study by Mireault et al. (2014) that reported the social referencing behaviors of 6- and 12-month-old infants toward a humorous stimulus. Mireault et al. found that by 12 months of age infants would smile toward the stimulus after referencing their caregivers when the caregivers were displaying a positive emotional expression, but the infants were much less likely to smile toward the stimulus when caregivers displayed neutral expressions. This indicates that the affect displayed by the caregiver had an impact on the likelihood that the infant would interpret the event as humorous. Indeed, the present study found that a majority of infants increased time spent referencing their caregivers between the two ages. Thus, the positive affect evoked by the stimuli in the 10-month-olds in the present study may have been dampened by the failure of their caregivers to also show positive emotional expressions.

Overall, the findings from this study did not support the original hypothesis that positive emotional responding would increase between the two ages of assessment. Failure to find an effect could be due to the methodologies implemented, environmental exposure to television and a habituation to novel images on a screen, and/or the effects of maternal referencing.

**Hypothesis 3**

**Negative emotional responding**. Negative emotional responding was also coded in this study to provide a more comprehensive view of the patterns of emotional responding of infants across conditions and ages. Inconsistent with expectations, it was found that at both ages of assessment, duration and intensity of negative affect were not reduced

 

in the majority of infants by either the audio-only or the audio-video condition. However, the predicted effect was found when the emotionally unresponsive infants were removed from analysis, which provides support that the negative emotions of emotionally responsive infants can be placated by the positive emotional stimuli.

Cohen (2002) found that during situations that cause infant distress, behavioral distress is reduced by providing a distracting stimulus for the infant. In the present study, some infants appeared to become distressed by the confinement of the infant chair they were seated in during the stimulus presentation. The level of positive emotional intensity in the stimuli may have provided enough distraction to reduce the intensity and duration of distress elicited by the confinement of the infant chair.

**Negative emotional responding from 5 to 10 months**. A secondary aim of Hypothesis 3 was to determine how negative emotional responding differed across ages. Findings in this area supported the previous explanations of overstimulation by the stimulus and distress due to the infant seat used in the study. The number of infants who fit the specified pattern indicated that the control was most effective (but still significantly fewer than half of the infants) in reducing negative emotional responding between the two ages. The explanation of visual stimulation can account for this difference compared to the experimental conditions. The control condition had brightly colored, rapidly changing visual stimuli that may have acted as a distractor from the infants' distress.

A possible explanation as to the lack of decrease in duration and intensity of negative emotional responding between 5 and 10 months of age might be attributed to the distress that was evoked by the confinement of the chair. Anecdotally speaking, experimenters found it to be more difficult to place the infants in the 10-month chair, buckle them in, and found that they often attempted to escape the confinement of the seat. Additionally, informal maternal reports support infant dissatisfaction with a restriction of mobility due to infant car seats and highchairs. Visual stimuli may have been effective in distracting the infants from their distress due to immobility. However, as inclusion criteria for the 10-month assessment required that infants be locomotive, failure to find reductions in the duration and intensity of negative emotional responding between the ages of 5 and 10 months could have been due to an overall increase in distress caused by immobility after they were capable of locomotion.

## Implications

Emotional contagion is important in that is a building block to more mature forms of empathic behavior. Prosocial behavior, a core concept of empathy, is essential to the ability to form close relationships, maintain friendships, and survive within a social world through the understanding of another's emotional state. In addition to personal relationships, these skills are also necessary for success in the workplace. Understanding emotional contagion and the mechanisms behind it will allow for a greater understanding of the development of these behaviors. The observation of the phenomenon of emotional contagion in infancy may give insight into the future behaviors of individuals and their ability to empathize with others. More specifically, the understanding of positive emotion early in the developmental period is important for understanding future emotional behaviors of an individual. In fact, individuals with low levels of positive emotionality in toddlerhood were found to have higher levels of depressive behaviors, suggesting that positive emotion is critical to the development of emotion and behavior (Hayden, Klein, Durbin, & Olino, 2006).

 

Both empathic happiness and empathic concern are related to positive emotion, because empathic happiness can bring about empathic concern (Decety, 2012). A study by Young, Fox, and Zahn-Waxler (1999) assessed infants at 4 months and again at 2 years. Infants who demonstrated high positive affect at 4 months of age subsequently displayed a higher degree of distress (empathic concern) towards another's distress.

The finding that positive emotional contagion can be evoked in 5-month-old infants provides supporting evidence to the theory of emotional contagion as a building block for more mature forms of empathy, which could potentially be influential in future studies of both negative and positive emotional contagion and empathy responding. The lack of effect at 10 months of age indicates that either the methodologies implemented in this study or certain environmental or developmental effects occur between the ages of 5 and 10 months that reduce the tendency to differentially respond with positive affect to social vs. non-social stimuli. Together these findings open a new area of study in developmental and empathy-related research that can and should be built on in the future.

## Limitations and Future Directions

Laughter and smiling most often occur during social interactions. The use of recorded auditory and visual stimuli as opposed to a live model may have resulted in the lack of emotional convergence with the emotions displayed by the stimuli. Difficulty in obtaining multiple infants simultaneously for observation, coupled with the inability to ensure the production of positive expression from a live infant model, made the use of recorded visual and auditory stimuli necessary. Additionally, the lack of familiarity with the infants used to create the stimuli may have also led to a lack of emotional response from the infant participant. Haviland and Lelwica (1987) found that infants of 10 weeks of age would only display an emotional response when a live model was used and when the infant was familiar with the model (usually a primary caregiver). While this was necessary for younger infants, previous literature did not allude to the idea that these stipulations would be necessary to evoke an emotional response at 5 and 10 months of age. The present study aimed to use peers (same aged infants) of the participants in order to more closely model the studies observing contagious crying. However, future research could consider using primary caregivers as the models of emotional displays.

Another limitation to this study was the use of a confining infant seat at the 10-month assessment. Due to the nature of the stimulus and in order to maintain the infants' attention, a seat with a buckle was required to keep the infant in place. The increase in negative emotional responding at the 10-month assessment may have been due to irritability with the confining seat after infants have obtained locomotor abilities. Additional methodologies might be implemented in the future to reduce immobility of the infants during the stimulus presentation.

## Conclusion

The purpose of the present study was to examine a gap in the existing literature on emotional contagion and empathic responding in infancy. Due to the exploratory nature of this study, we hoped to find a contagious response to the positive affect of other infants in the form of either social smiling or overt laughter and that this response would increase across a developmental period. In part, the findings supported the original hypotheses in that positive emotional responding to a positively charged stimulus was found in the way of

 

social smiling, but not overt laughter. Furthermore, positive emotional contagion was not found to increase across the developmental period. In fact, positive emotional contagion was found to occur in only a minority of the 10-month-old infants. Evidence of this occurrence provides an initial platform for further exploration in the area of positive affect in infancy and early childhood.

Exploratory analyses indicated that the same positive stimulus was not effective in reducing the behavioral distress exhibited by the infants at both 5 and 10 months of age. This may indicate that negative emotions are not able to be overcome by positive emotional stimuli or that the stimuli were not stimulating or social enough to distract from the infant's distress. Although this was not part of the initial hypothesis, it provides insight as to the full spectrum of emotional responding which provides a greater understanding of how infants respond to the specific stimuli implemented in this study.

## References

Anderson, D. I., Campos, J. J., Witherington, D. C., Dahl, A., Rivera, M., He, M., … Barbu-Roth, M. (2013). The role of locomotion in psychological development. *Front. Psychol., 4*. doi:10.3389/fpsyg.2013.00440

Brown, G. E., Brown, D., & Ramos, J. (1981). Effects of a laughing versus a nonlaughing model on humor responses in college students. *Psychological Reports*, 17, 35-40. doi: 10.2466/pr0.1981.48.1.35

Campos, J. J., Witherington, D., Anderson, D. I., Frankel, C. I., Uchiyama, I., Barbu-Roth, M. (2008). Rediscovering development in infancy. *Child Development*, 6, 1625-1632. doi:10.1111/j.1467-8624.2008.01212.x

Campos, J. J., Anderson, D. I., Barbu-Roth, M. A., Hubbard, E. M., Hertenstein, M. J., & Witherington, D. (2000). Travel broadens the mind. *Infancy, 1*, 149-219. doi:10.1207/S15327078IN0102_1

Chapman, A. J., Chapman, W. A. (1974). Responsiveness to humor: Its dependency upon a companion's humorous smiling and laughter. *Journal of Psychology, 88*, 245-252. doi: 10.1080/00223980.1974.9915735

Christakis, D. A., Zimmerman, F. J., DiGiuseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Pediatrics*, 113(4), 708-713. doi:10.1542/peds.113.4.708

Cohen, L.L. (2002). Reducing infant immunization distress through distraction. *Health Psychology*, 21, 207-211. doi.org/10.1037/0278-6133.21.2.207

Decety, J. (2012). *Empathy: From bench to bedside*. Cambridge, Mass: MIT Press. doi:10.7551/mitpress/9780262016612.001.0001

Decety, J., & Jackson, P. L. (2004). The Functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews, 3*, 406-412. doi:10.1177/1534582304267187

Dezecache, G., Jacom, P., Grezes, J. (2015) Emotional contagion: Its scope and limits. *Trends in Cognitive Sciences, 19*, 297.

Feinman, S., & Lewis, M. (1983). Social referencing at ten months: A second-order effect on infants' responses to strangers. *Child Development, 54*, 878-887. doi:10.2307/1129892

 

Geangu, E., Benga, O., Stahl, D., & Striano, T. (2010). Contagious crying beyond the first days of life. *Infant Behavior & Development, 33*, 279-288. doi: 10.1016/j.infbeh.2010.03.004

Grice, J. (2011). Observation oriented modeling: An introduction. New York: Elsevier.

Grice J.W., Barrett P.T., Schlimgen L.A., & Abramson C.I. (2012) Toward a Brighter Future for Psychology as an Observation Oriented Science. *Behavioral Sciences, 2(1)*, 1-22. doi:10.3390/bs2010001

Grice, J. W., Craig, D. P. A., & Abramson, C. I. (2015). A simple and transparent alternative to repeated measures ANOVA. Sage Open, July-September, 1-13. doi: 10.1177/2158244015604192

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1993). Emotional contagion. *Current Directions in Psychological Science, 2*, 96-99. doi:10.1111/1467-8721.ep10770953

Haviland, J. M., & Lelwica, M. (1987). The induced affect response: 10-week-old infants' responses to three emotion expressions. *Developmental Psychology, 23*, 97-104. doi:10.1037/0012-1649.23.1.97

Hayden, E. P., Klein, D. N., Durbin, C. E., & Olino, T. M. (2006). Positive emotionality at age 3 predicts cognitive styles in 7-year-old children. *Development and Psychopathology, 18*, 409–423. doi:10.1017/S0954579406060226.

Hoffman, M. L. (2000). *Empathy and moral development: Implications for caring and justice*. New York, NY, US: Cambridge University Press. doi: 10.1017/cbo9780511805851

Hsee, C. K., Hatfiled, E., Carlson, J. G., Chemtob, C. (1990). The effect of power on susceptibility to emotional contagion. *Cognition and Emotion*, 4, 327-340. doi: 10.1080/02699939008408081

Hutman, T., & Dapretto, M. (2009). The emergence of empathy during infancy. *Cognition, Brain, and Behavior*, *13*(4), 367-390.

Izard, C., Dougherty, L., & Hembree, E. (1983). *A system for identifying affect expressions by holistic judgments (Affex)* (Rev. ed.). Newark, Del.: Instructional Resources Center, University of Delaware.

Jones, S.S., & Ragg, T. (1989). Smile production in older infants: the importance of a soial recipient for the facial signal. *Child Development, 60*, 811-818. doi:10.2307/1131021

Kahana-Kalman, R., & Walker-Andrews, A. S. (2001). The role of person familiarity in young infants' perception of emotional expressions. *Child Development, 72*, 352-369. doi:10.1111111467-8624.00283

Laurent, H. K., Ablow, J. C., & Measelle, J. (2012). Taking stress response out of the box: Stability, discontinuity, and temperament effects on HPA and SNS across social stressors in mother-infant dyads. *Developmental Psychology*, 48, 25-45. doi: 10.1037/a0025518

Martin, G. B., & Clark, R. D. (1982). Distress crying in neonates: Species and peer specificity. *Developmental Psychology, 18*, 3-9. doi:10.1037/0012-1649.18.1.3

Meltzoff, A. N., & Moore, M. (1989). Imitation in newborn infants: Exploring the range of gestures imitated and

 

the underlying mechanisms. *Developmental Psychology*, *25*, 954-962. doi:10.1037/0012-1649.25.6.954

Mireault, G. C., Crockenberg, S.C., Sparrow, J.E., Cousineau, K., Pettinato, C., & Woodward, K. (2015). Laughing matters: Infant humor in the context of parental affect. (2015). *Journal of Experimental Child Psychology.*, *136*, 30. doi.org/10.1016/j.jecp.2015.03.012

Mireault, G. C., Crockenberg, S.C., Sparrow, J.E., Pettinato, C.A., Woodward, K.C., & Malzac, K. (2014). Social looking, social referencing and humor perception in 6-and 12-month-old infants. *Infant Behavior and Development*, 37, 536-545. doi:10.1016/j.infbeh.2014.06.004

Pfeifer, J. H., Iacoboni, M., Mazziotta, J. C., & Dapretto, M. (2008). Mirroring others' emotions relates to empathy and interpersonal competence in children. *NeuroImage*, *39*, 2076-2085. doi:10.1016/j.neuroimage.2007.10.032

Provine, R. R. (1992). Contagious laughter: Laughter is a sufficient stimulus for laughs and smiles. *Bull. Psychon. Soc.*, *30*, 1–4. doi:10.3758/bf03330380

Provine, R. R. (2004). Laughing, tickling, and the evolution of speech and self. *Current Directions in Psychological Science*, *13*, 215-218. doi:10.1111/j.09637214.2004.00311.x

Rothbart, M. K. (1989). Temperament and development. In G. A. Kohnstamm, J. E. Bates, &M. K. Rothbart (Eds.), Temperament in childhood (pp. 187–248). New York: Wiley.

Sagi, A., & Hoffman, M. L. (1976). Empathic distress in the newborn. *Developmental Psychology*, *12*, 175-176. doi:10.1037/0012-1649.12.2.175

Sallquist, J., Eisenberg, N., Spinrad, T. L., Gaertner, B. M., Eggum, N. D., & Zhou, N. (2010). Mothers' and children's positive emotion: Relations and trajectories across four years. *Social Development*, *19*, 799-821. doi:10.1111/j.1467-9507.2009.00565.x

Simner, M. L. (1971). Newborn's response to the cry of another infant. *Developmental Psychology*, *5*, 136-150. doi:10.1037/h0031066

Sorce, J. F., & Emde, R. N. (1981). Mother's presence is not enough: Effect of emotional availability on infant exploration. *Developmental Psychology*, *17*, 737-745. doi:10.1037/0012-1649.17.6.737

Sroufe, L., & Waters, E. (1976). The ontogenesis of smiling and laughter: A perspective on the organization of development in infancy. *Psychological Review*, *83*, 173–189. doi:10.1037/0033-295X.83.3.173

Thompson, R. A. (1987). Empathy and emotional understanding: The early development of empathy. In N. Eisenberg, J. Strayer (Eds.), *Empathy and its development* (pp. 119-145). New York, NY US: Cambridge University Press.

Turk-Browne, N. B., Scholl, B. J., & Chun, M. M. (2008). Babies and brains: Habituation in infant cognition and functional neuroimaging. *Frontiers in Human Neuroscience*, *2*, 16. doi:10.3389/neuro.09.016.2008

Walden, T. A., & Ogan, T. A. (1988). The development of social referencing. *Child Development*, *59*, 1230-1240. doi:10.1111/j.14678624.1988.tb01492.x

 

Wörmann, V., Holodynski, M., Kärtner, J., & Keller, H. (2012). A cross-cultural comparison of the development of the social smile: A longitudinal study of maternal and infant imitation in 6- and 12-week-old infants. *Infant Behavior & Development*, *35*, 335-347.doi:10.1016/j.infbeh.2012.03.002

Young, S. K., Fox, N. A., & Zahn-Waxler, C. (1999). The relations between temperament and empathy in 2-year-olds. *Developmental Psychology*, *35*, 1189-1197. doi:10.1037/0012-1649.35.5.1189.

Zimmerman, F. J., Christakis, D. A., & Meltzoff, A. N. (2007). Television and DVD/video viewing in children younger than 2 years. *Archives of pediatrics & adolescent medicine*, 161, 473-479. doi:10.1001/archpedi.161.5.4