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Family expressiveness relates to happy emotion matching among 9-month-old infants

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A B S T R A C T

Perceiving and understanding the emotions of those around us is an imperative skill to develop early in life. An infant's family environment provides most of their emotional exemplars in early development. However, the relation between the early development of emotion perception and family expressiveness remains understudied. To investigate this potential link to early emotion perception development, we examined 38 infants at 9 months of age. We assessed infants' ability to match emotions across facial and vocal modalities using an intermodal matching paradigm for angry–neutral, happy–neutral, and sad–neutral pairings. We also attained family expressiveness information via parent report. Our results indicate a significant positive relation between emotion matching and family expressiveness specific to the happy–neutral condition. However, we found no evidence for emotion matching for the infants as a group in any of the three conditions. These results suggest that family expressiveness does relate to emotion matching for the earliest developing emotional category among 9-month-old infants and that emotion matching with multiple emotions at this age is a challenging task.

Introduction

Emotion understanding, the ability to identify emotional expressions and reactions, enables individuals to make inferences about the feelings and behaviors of others, to react appropriately in social

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situations, and to maintain successful relationships. Prior research with children has revealed the importance of home environments in the development of early emotion understanding (Dunn, Brown, & Beardsall, 1991; Ontai & Thompson, 2002). Here, we examined the possibility that these experiences influence emotional development at younger ages, testing the hypothesis that infants who experience more emotionally expressive family environments will develop the necessary skills to perceive emotion earlier than infants from less expressive families.

Emotion understanding emerges early and promotes optimal social and intellectual development during childhood. By 2 years of age, for example, children can use the emotional signals of others to adjust their behavior toward objects in their environment (Walle, Reschke, Camras, & Campos, 2017). By 3 years, most children can label and identify basic emotions (Denham, 1986). Emotion understanding among preschoolers is positively related to classroom adjustment (Shields et al., 2001) and predicts kindergarten social competence (Denham et al., 2003), aggression (Denham et al., 2002), and academic success (Denham et al., 2012). In addition, individual differences in emotion understanding trajectories from 3 to 6 years of age are highly stable (Brown & Dunn, 1996) and remain stable from 7 to 11 years (Pons & Harris, 2005). These findings suggest that by the time children are in preschool, their level of emotion understanding already has strong implications for their later social, emotional, and academic development.

The importance of emotion understanding in preschool motivates investigations of its development among younger age groups, and prior research has begun to look at emotional development during infancy. However, measuring emotion understanding during infancy is challenging, because infants cannot verbally state what they do and do not know about various emotions. Infants also have limited motor skills, making it difficult to measure understanding of emotion via a physical task. Therefore, researchers must rely on experimental tasks to tap into emotion perception with infants (such as emotion discrimination and matching paradigms) to determine when they can discriminate or categorize emotional stimuli. Such methods assess emotion perception without making explicit how these skills are related to verbal responses of emotion understanding taken from older children. For instance, it is possible that infants match emotions in different modalities (as tested in the current study) from experience in seeing and hearing happy (or angry or sad) faces and voices together without understanding their "meaning."

By 6 months of age, infants can discriminate between static images of various emotions such as happy versus angry or neutral (LaBabera, Izard, Vietze, & Parisi, 1976) and fear versus sadness (Schwartz, Izard, & Ansul, 1985). Four-month-olds can categorize emotions across synchronous audiovisual pairings, and categorization of vocal and facial emotional stimuli independently emerges at 5 and 7 months, respectively (Flom & Bahrick, 2007). Studies using the intermodal preference technique (Spelke, 1976) have indicated that 7-month-olds can match happy and sad emotions across face and voice even when the stimuli are asynchronous (Walker, 1982) and that 3.5-month-olds can match happy and sad faces and voices when the stimulus is the infant's own mother (Kahana-Kalman & Walker-Andrews, 2001). Moreover, 5-month-olds are sensitive to changes in emotional tones of voice (Walker-Andrews & Grolnick, 1983), and 7-month-olds can match the emotion of a face and voice even when the bottom third of the face is occluded (Walker-Andrews, 1986).

Individual differences in emotion understanding are stable from 3 to 6 years of age (Brown & Dunn, 1996), and identifying variables that contribute to emotion perception in infants may offer important insights into how emotion perception and early emotion understanding develop—the question we examined in the current study. Studies of individual differences during infancy have found, for example, relations between infant sensitivity to smiling faces and the mother's encouragement to look at her when she smiled (Kuchuk, Vibbert, & Bornstein, 1986). In addition, 5-month-old infants of depressed mothers are at a disadvantage in emotion discrimination, such that they fail to discriminate neutral and smiling faces in a habituation paradigm, whereas their age-matched peers succeed (Bornstein, Arterberry, Mash, & Manian, 2011). Much remains unknown about contributions to early emotion perception on an individual basis. Of notable interest is the potential influence of infants' social environments, in particular family expressiveness, on individual differences in infants' emotion perception.

Prior research has shown a relation between emotion understanding and family functioning among preschool-aged children (Nixon & Watson, 2001) as well as emotion understanding and family discussions about emotions (Dunn et al., 1991). However, the relation between emotional development and family *expressiveness* in infants and young children is less clear. Retrospective accounts of childhood family expressiveness among adults have revealed that family expressiveness is negatively related to accuracy in judging emotional expressions of faces (Halberstadt, 1983, 1986; Halberstadt, Dennis, & Hess, 2011) but is positively related to perception of emotional intensity (Halberstadt et al., 2011). This is theorized to be the case because growing up in a low-expressivity home may cause a child (over time) to learn to rely on subtle emotional cues for identifying others' feelings. In contrast, highly expressive homes may help a child to be particularly sensitive to changes in emotional intensity due to greater variability in the environment. These results imply that family expressiveness may have multiple roles in emotional development and lend credibility to the idea that exposure to emotional expressivity during infancy and childhood can have a substantial impact on later perception of emotional expressions (cf. Miller, Caul, & Mirsky, 1967). However, whether family expressivity influences infant emotional development, and how it may do so, remains relatively unexplored. Insights in this area will allow for better understanding early emotional development and, potentially, how to alter infant environments to improve developmental outcomes.

The current study

In the current study, we asked whether family expressiveness was associated with 9-month-old infants' performance on an intermodal emotion matching task. We presented infants with happy, sad, and angry talking faces, each paired with a neutral face. These emotions were selected because angry, happy, and sad are the first emotions to be recognized and labeled and are commonly used in preschool assessments of emotion understanding (Denham, 1986; Widen, 2013). The three emotional faces were each paired with a neutral face. This allowed us to assess how well infants could match emotional faces and voices for angry, happy, and sad under comparable conditions (each when paired with neutral). Each paired presentation either was silent or included a voice that matched one of the videos in emotional tone, with facial movements being asynchronous with voice during the video. The dependent variable was the degree to which the infants matched the asynchronous voice to the appropriate face, operationalized as greater looking to the matching face relative to silence. Our task was challenging by design so as to elicit a wide range of emotion matching scores. We analyzed for individual differences in performance and relations of these differences to family expressiveness, which was collected via parent report. Given that 5-month-old infants of depressed mothers (mothers who tend to be less emotionally expressive) already show deficits in emotion discrimination relative to their peers (Bornstein et al., 2011), we hypothesized that family expressiveness would be correlated with emotion matching among typically developing 9-month-olds.

Method

Participants

A total of 38 healthy, full-term 9-month-old infants ranging from 7.82 to 10.38 months participated in the study (M_{age} = 9.15 months, *SD* = 0.63; 20 male). Although slightly younger infants have been shown to emotion match previously (e.g., Walker, 1982), we selected this age range to account for the (presumably) more challenging nature of our task. An additional 2 infants were excluded from the final dataset due to fussiness. Of the final sample, 35 infants had a parent who had completed 4 years of college. The ethnic/racial background of participants was as follows: Caucasian ($n = 22$), multiracial ($n = 11$), Asian ($n = 2$), Pacific Islander ($n = 1$), African American ($n = 1$), and Latino ($n = 1$). Of the 38 infants, 18 spent time away from their immediate family on a weekly basis (*M* = 30.0 h, *SD* = 14.8). These 18 children did not differ from the other 20 in terms of emotion matching or Family Expressiveness Questionnaire (FEQ) scores (all $ps > .10$). Infants were recruited from lists of birth records provided by Los Angeles County as part of a larger longitudinal study. Parents were provided with $30 in cash and a small gift (e.g., a T-shirt or toy) for participating.

Materials

Surveys

Parents (36 mothers and 2 fathers) provided written informed consent and completed a demographic questionnaire and the FEQ (Halberstadt, 1986). The FEQ asked how frequently (Likert scale, 1–9) individuals in the infant's immediate family environment express themselves in given situations. For example, parents were asked how frequently someone in the household might "express gratitude for a favor," "exclaim over a beautiful day," "show contempt for another's actions," and "show dislike for someone" when they are around family members. The questionnaire has high test–retest reliability, significantly similar responses among family members, and responses that are distinct from self-expressiveness or self-reports of shyness (Halberstadt, 1986). Therefore, this is a reliable and valid measure for assessing family expressiveness. The questionnaire contained 40 questions, resulting in a minimum possible total FEQ score of 40, and a maximum of 360. Each individual question in the FEQ represented either positive or negative family expressiveness, allowing the FEQ to be divided into positive and negative subscales (Burrowes & Halberstadt, 1987). The positive and negative FEQ subscales each had a minimum possible score of 20 and a maximum possible score of 180.

Stimulus creation

For audio and video stimuli of happy, sad, angry, and neutral emotions, a female model was recorded as she read 10-s child-appropriate scripts. The following is an example script for each emotion: angry—"My brother won't let me play with him. He told me I was too little. Now I have to watch him play with his friends"; happy—"I went to the beach with all my friends. We played in the water. It was so much fun. I can't wait to go back"; sad—"My favorite toy broke. I dropped it. My mom says it can't be fixed. Now I don't know what to play with"; neutral—"I have a brother and a sister. My brother plays baseball. My sister plays soccer. I play tennis." Each script contained between 22 and 32 syllables. The number of syllables did not differ significantly across the four different emotions, as determined by analysis of variance (ANOVA), $F(3, 5) = 1.18$, $p = .405$, making it unlikely that infants could match audio and video contents based solely on rate of speech.

When recording the stimuli, the model was instructed to think about a time when she felt the target emotion and to convey the emotion through her face and voice. She was then seated against an off-white background while she read each script facing directly toward the camera. She was recorded from the shoulders up and used only small, natural head movements during each recording. Each of the 10-s clips was separated into independent video and audio files. Final Cut Pro and Avidemux were used for final edits.

Stimulus validation

To validate the emotional content of the video and audio clips, they were presented to adults in a Qualtrics survey. A total of 58 adults (13 male) between 18 and 55 years of age viewed each audio and video clip independently, with no sound during the video-only clips and only a plain blue screen visible during the audio-only clips. After each stimulus presentation, the adults decided whether the emotion conveyed in the clip was happy, sad, angry, afraid, or neutral. These survey responses were then used to select the best examples of each emotion for the current study. This resulted in two audio and video clips each for happy, sad, and angry as well as three neutral audio and video clips. The third neutral clip was included to prevent over-familiarity with the neutral stimuli given that neutral stimuli were presented most often. The selected audio and video clips were correctly identified by an average of 91% of the Qualtrics survey participants (angry = 88%, happy = 95%, sad = 92%, neutral = 87%), and each clip followed a different written script (i.e., no two audio clips and no two video clips involved the model saying the same thing). Additional information about adult ratings of the stimuli is presented in Table 1.

Apparatus

The experiment was programmed with Experiment Builder, the proprietary stimulus presentation software associated with the eye tracker (EyeLink 1000; SR Research, Ottawa, Ontario, Canada) used to collect information about infants' fixations to the emotional stimuli. Two video clips were shown next

Table 1
Adult ratings of emotional stimuli (%).

Depicted emotion	Adult response				
	Afraid	Angry	Happy	Sad	Neutral
Angry	0	87.9	0.5	11.1	0.5
Happy	0	0	95.2	0	4.8
Sad	4.1	2.5	0.5	92.4	0.5
Neutral	3.7	1.3	4.2	4.2	86.7

to each other on every trial. Each video was 18.1 × 13.6 cm (~30.0° × 22.5° visual angle at the infants' 60-cm viewing distance), and the two videos were separated by a blank space of 6.8 cm (11.3°). Fig. 1 shows a still image example of the visual stimuli. One video was always a neutral clip, and the other video was one of the three remaining emotions (happy, sad, or angry). Stimulus presentation was separated into three blocks, with each block containing six 10-s trials. Two different happy, sad, and angry video clips were presented per block in random order. Side of video presentation (left or right) was also randomized, with the condition that no more than two neutral videos were presented on the same side on subsequent trials. The first block of clips was presented in silence to determine each infant's baseline preference for the three trial types. This baseline trial allowed us to investigate emotion matching while still accounting for initial baseline preferences on an individual basis.

Audio clips were played in Blocks 2 and 3. The single audio clip for a given trial always matched the emotional tone of one of the videos that was concurrently presented, always asynchronous with either video. Asynchrony was necessary to ensure that the infants did not match the emotions based on temporal synchrony of voice and lip movement given that infants as young as 3.5 months are sensitive to synchrony of audio and video (Bahrick, 1992). Across Blocks 2 and 3, six neutral, two angry, two happy, and two sad audio clips were presented. Order of the audio clips was randomized, with the constraints that no more than two neutral audio clips were presented in a row and the audio matched the emotional tone of one of the videos from the same trial but not the script. That is, because each

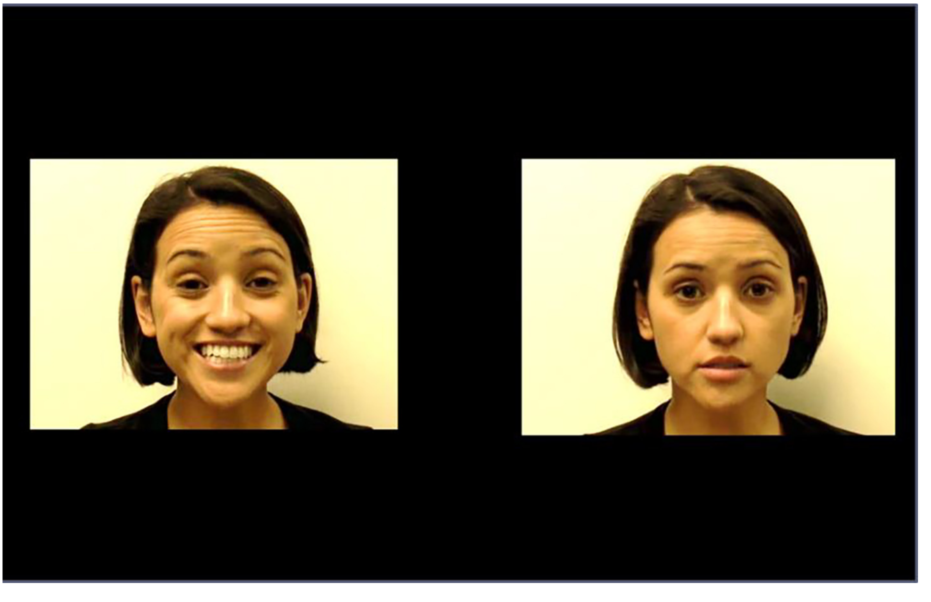

Fig. 1. Happy–neutral emotion matching stimulus. A still image example of a stimulus presented to infants is shown, with a happy face presented on the left and a neutral face presented on the right.

emotion contained at least two possible scripts, if the model visually displayed was saying the first angry clip and the audio was angry, the audio would need to be of the second angry clip to avoid synchrony. The study design was informed by Walker's (1982) intermodal emotion matching paradigm, with the novel incorporation of the baseline silent condition.

Procedure

Infants were seated on a parent's lap approximately 60 cm from a 56-cm monitor. The eye tracker was used to record each infant's eye movements at 500 Hz. Prior to introduction of the stimuli, each infant's gaze was calibrated using the standard calibration routine provided by the eye tracker. An attention-getting stimulus was presented at each of five locations (the four corners and the center of the screen) as the infant tracked each location. The experimenter controlled progression through the five calibration stimuli, moving on to the next location once the child had fixated on the previous location. If the calibration was poor for a particular location, that point was repeated. After calibration was completed, the calibration was validated by presenting the same five attention-getting stimuli again. If the validated fixations were within 1° visual angle error from the calibration fixations, the calibration was considered acceptable and the experiment advanced to presentation of the emotional stimuli. If the validation fixations did not meet this criterion, the calibration was repeated until this threshold was met.

During the task, each 10-s trial was preceded by a small attention-getting stimulus in the center of the screen to recenter the child's gaze prior to the next trial. Parents were instructed to hold their infant on their lap and to allow the child to look freely during the experiment. Parents were asked not to point to the screen, direct their child's attention, or otherwise interact with the child except to turn the infant's body back toward the screen during presentation of the attention-getting stimulus if the child had completely disengaged his or her attention on the prior trial.

Results

Descriptive statistics

FEQ values observed in our sample are reported in Table 2 and are comparable to previously reported FEQ values completed by parents (Ramsden & Hubbard, 2002).

Statistical analyses

Emotion matching was operationalized as greater attention to the face that matched the emotional tone of the voice compared with looking to the same emotional face in silence. Emotion matching scores were calculated using proportions to accommodate a slight decline in overall looking from the trials presented first to later-presented trials (on average, infants looked to the screen for 7.9 of 10 s on silent trials [*SD* = 1.7] and for 7.1 of 10 s on audio trials [*SD* = 2.0]). Therefore, attention to each face was calculated as the proportion of looking to that particular face out of total time spent looking to the two faces for that trial. A separate emotion matching score was calculated for each of the three trial types (angry–neutral, happy–neutral, and sad–neutral) because the three pairings each provide unique information, and thus we did not combine these scores. Emotion matching was then calculated as a difference score using proportions (i.e., the change in proportion of looking to a given face from

Table 2
FEQ results.

Subscale	Mean	Standard deviation	Observed range
Total	212.8	34.0	127–275
Positive	139.7	24.2	60–172
Negative	73.1	23.0	33–122

the silent trials to the audio trials). To yield one dependent variable for each trial type, the emotion matching score was averaged across the emotional- and neutral-voiced trials. Therefore, the emotion matching score represented overall how much the infant changed his or her pattern of looking from the silent trials to the audio trials for both the emotional and neutral voices, indicating the infant's overall ability to emotion match for that trial type. Emotion matching scores were used as dependent variables in most analyses.

Individual trials were removed from analyses if the child looked at the screen for less than 2 s of the 10-s trial. This resulted in removal of an average of 0.55 of 18 possible trials per participant. Outliers more than 3 standard deviations from the mean were also excluded from analyses ($n = 1$, happy condition).

Emotion matching

Descriptive statistics for infant looking patterns are reported in Table 3. To assess whether, as a group, infants looked more to a particular face in the presence of a matching voice versus silence, we used one-sample, two-tailed *t* tests. We compared the emotion matching scores for angry, happy, and sad trials with a value of 0, which would indicate no change in looking between the sound-matched and silent trials. Group data revealed no significant change for the angry condition, $t(37) = 0.241$, $p = .811$, the happy condition, $t(36) = 0.869$, $p = .391$, or the sad condition, $t(37) = -0.846$, $p = .403$. Average emotion matching scores for these three conditions are depicted in Fig. 2. We did not observe any differences in emotion matching between the second and third blocks [angry: $t(29) = 1.378$, $p = .179$; happy: $t(33) = 0.148$, $p = .884$; sad: $t(31) = 0.971$, $p = .339$], indicating that our emotion matching result was not affected by a fatigue effect across Blocks 2 and 3. Overall, these results suggest that an intermodal matching paradigm that incorporates multiple emotions and a silent baseline condition is challenging for infants at 9 months of age.

Although evidence for emotion matching did not reach significance in any of the three conditions, the results were closest to significance in the happy condition. To further explore differences between conditions, we identified the number of participants who increased their looking to the matching face (positive emotion matching value) versus decreased looking to the matching face (negative emotion matching value) in each of the three conditions. The results were as follows: angry—positive ($n = 16$), negative ($n = 22$); happy—positive ($n = 21$), negative ($n = 16$); sad—positive ($n = 18$), negative ($n = 20$). Thus, the happy condition produced the most increased looking to the matching face and was the only condition in which more participants had a positive emotion matching value than had a negative emotion matching value. This may indicate that participants are beginning to emotion match in the happy condition before either the sad or angry condition.

Next, we analyzed the audio trials as in previous studies (Walker, 1982; Walker-Andrews, 1986). We compared each infant's proportion of looking to the face that matched the audio with chance level (.50) for all audio conditions. This revealed that infants looked slightly more at the angry face when hearing the angry voice, although this was not significant, $t(37) = 1.859$, $p = .071$, looked significantly more at the happy face when hearing the happy voice, $t(36) = 8.304$, $p < .001$, and looked about equally at the two faces when hearing the sad voice, $t(37) = 0.841$, $p = .406$. However, when hearing the neutral voice, there was a trend toward looking more at the angry face, although nonsignificant, $t(37) = 1.868$, $p = .070$, more looking at the happy face, $t(36) = 6.032$, $p < .001$, and more looking at the sad face, $t(37) = 2.488$, $p = .017$. This indicates that the infants in our study preferred the angry, happy, and sad faces over the neutral face, regardless of audio.

Table 3
Proportions of time (and standard deviations) infants spent looking to each face by audio type.

Trial type	Silent		Neutral voice		Non-neutral voice	
	Neutral	Non-neutral	Neutral	Non-neutral	Neutral	Non-neutral
Angry	.43 (.11)	.57 (.11)	.45 (.16)	.55 (.16)	.44 (.20)	.56 (.20)
Happy	.32 (.10)	.68 (.10)	.36 (.18)	.64 (.18)	.31 (.14)	.69 (.14)
Sad	.45 (.13)	.55 (.13)	.44 (.14)	.56 (.14)	.47 (.19)	.53 (.19)

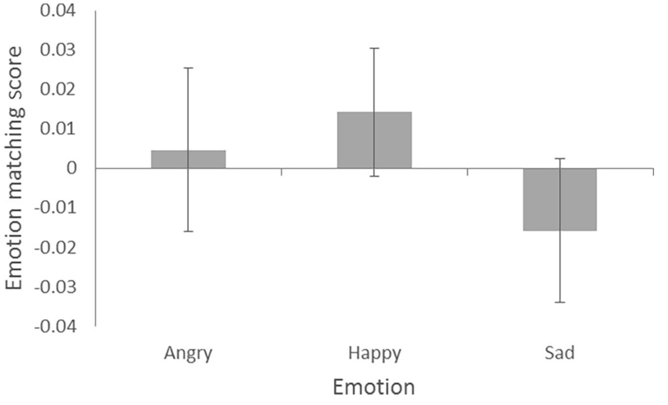

Fig. 2. Change in looking time from silent to sound-matched trials. The bar graph displays change in proportion of looking time from the silent condition to the condition where the face matches the emotion of the voice for angry, happy, and sad conditions. Error bars indicate standard errors of the mean.

We used two separate multivariate simple linear regressions to determine whether emotion matching scores were related to demographic variables. When we regressed each emotion matching score onto child sex ($F = 0$, $M = 1$), we found no significant relation for any of the three conditions [angry: $F(1, 35) = 1.07$, $p = .308$; happy: $F(1, 35) = 0.06$, $p = .816$; sad: $F(1, 35) = 1.08$, $p = .307$]. Similarly, we assessed relations to maternal education, such that the mother's highest level of education was coded as follows: elementary school = 0, middle school = 1, high school or equivalent = 2, community college/vocational school = 3, 4-year college/university degree = 4, professional degree/graduate school = 5. Among our sample, maternal education ranged from 2 to 5 ($M = 4.26$, $SD = 0.89$). When we regressed the emotion matching scores onto maternal education, we also found no significant relations for any of the three conditions [angry: $F(1, 35) = 0.19$, $p = .903$; happy: $F(1, 35) = 1.11$, $p = .360$; sad: $F(1, 35) = 1.30$, $p = .289$].

Family expressiveness and emotion matching

To test whether family expressiveness related to infants' emotion matching scores, we ran a multivariate simple linear regression. When we regressed each emotion matching score onto FEQ total score, we found a significant relation for the happy condition, $F(1, 35) = 6.20$, $p = .018$, but not for either the angry condition, $F(1, 35) = 0.07$, $p = .798$, or the sad condition, $F(1, 35) < .01$, $p = .978$. The positive relation for the happy condition (depicted in Fig. 3) implies that the more total expressivity there was in the child's environment, the more the child attended to the face that matched the emotional tone of the voice relative to baseline during happy trials.

To determine whether this result was an effect of emotion matching, and not driven by baseline emotional preferences, we ran a multivariate simple linear regression comparing FEQ total score with the proportion of looking to the angry, happy, and sad faces at baseline. Our results indicated no significant relation between total FEQ and baseline looking patterns [angry: $F(1, 35) = 5.07$, $p = .062$; happy: $F(1, 35) = 2.50$, $p = .193$; sad: $F(1, 35) = 0.94$, $p = .612$].

To investigate how the positive and negative FEQ subcomponents may have contributed to the significant relation between happy emotion matching and total FEQ, we ran two additional regression analyses for only the happy condition. When the happy emotion matching score was regressed onto the FEQ positive score, there was no significant relation ($r = .260$, $p = .121$); when regressed on the FEQ negative score, the relation approached significance ($r = .298$, $p = .073$). Although we cannot statistically compare the regression for total FEQ with the regressions for positive and negative FEQ because the latter are subcomponents of the former, the strength of the results seems to suggest that the relation between total FEQ and happy emotion matching was not fully accounted for by either positive or negative FEQ independently.

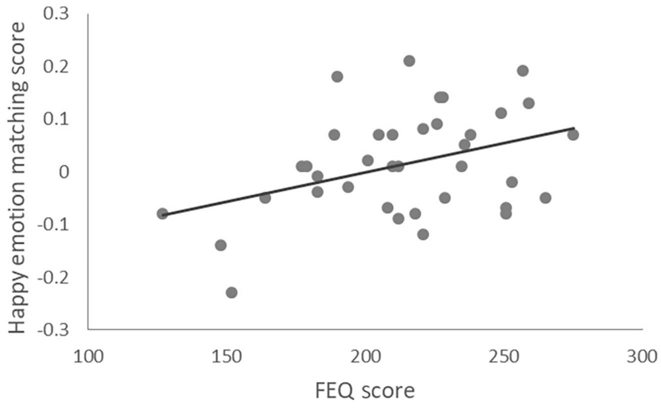

Fig. 3. Scatterplot displaying positive correlation between Family Expressiveness Questionnaire (FEQ) total score and change in proportion of looking time from the silent condition to the condition where the face matches the emotion of the voice for happy trials (B = .001, SE = .0004).

Discussion

To our knowledge, this is the first study to investigate infants' ability to match multiple emotional face and voice pairings at 9 months of age and to assess whether individual differences in emotion matching were related to family expressiveness. Although infants as a group did not emotion match for the angry, happy, or sad condition, we found a positive relation between family expressiveness and emotion matching for happy trials. These results provide an important foundation for understanding how family expressiveness influences emotion perception early in development; more broadly, our study demonstrates that understanding family environments can yield unique perspectives on infants' social development.

The positive relation between total family expressiveness and emotion matching for happy trials appears to be inconsistent with the *socialization hypothesis* (Lanzetta & Kleck, 1970), which suggests that individuals who learn through their environment to minimize emotional displays are those who are more sensitive to the emotional displays of others. Studies with adults have shown that family expressiveness is positively related to emotional expressivity but is negatively related to judgments of others' emotional expressions (e.g., Halberstadt, 1983). However, age may affect the relation between family expressiveness and emotion perception (Halberstadt & Eaton, 2002). Our results suggest that, among 9-month-olds, the socialization hypothesis might not be the best account of emotion perception. Because the first 2 postnatal years are characterized by significant developments in infants' social cognition (Brownell, 2012; Grossmann & Johnson, 2007), exposure to a variety of emotions in the family environment at this time may be particularly beneficial for early emotion perception. Our pattern of results specific to the happy condition, but not to the angry or sad condition, may make sense in this context because categorization of happy emerges earlier than other emotional categories (Grossmann, 2010) and, therefore, may be the first to display this relation. That is, infants as a group did not provide evidence for emotion matching in happy–neutral trials, yet the emotion matching value was the highest in this condition and more participants had positive emotion matching values than negative ones, suggesting that happy emotions may be first to be matched intermodally.

The finding that total family expressiveness, but not positive or negative family expressiveness independently, was significantly related to happy emotion matching was of interest. It was not the case that happy emotion matching skills were associated solely with frequency of exposure to smiles and positive emotions. Rather, happy emotion matching was significantly related to greater exposure to *total expressiveness*. This finding makes sense given what we know about category learning; children often learn what belongs to a category best when they are given *comparison* exemplars, which belong to the category being learned, as well as *contrast* exemplars, which do not belong to the category (Ankowski, Vlach, & Sandhofer, 2013; Gentner & Namy, 1999; Gentner, Anggoro, & Klibanoff, 2011). Perhaps infants, likewise, learn to match emotions best when exposed to emotional content from the happy category (positive family expressiveness) as well as examples outside the happy category (negative family expressiveness). In the future, researchers may wish to further investigate this possibility in perception of a variety of emotions across early development.

Relations between infants' emotion matching and family expressiveness are important because they provide insight into potential mechanisms of early emotion perception. Exposure to variability in the emotions of others may be key for early emotion matching development. Our results may provide a first step toward identifying the sorts of emotional environments that are most beneficial for emotional development among a typically developing population. This information may benefit the design of interventions to aid emotion perception prior to the stabilization of early emotion understanding (Brown & Dunn, 1996) as part of a healthy foundation for social development.

Overall, the infants we observed did not match audiovisual emotional content, contrasting with previous studies reporting that infants younger than 9 months are capable of emotion matching across face and voice (Soken & Pick, 1992; Walker, 1982; Walker-Andrews, 1986). Differences in study designs may account for these conflicting findings. First, our design included a silent baseline trial, unlike the previous studies. This baseline trial gave us the advantage of being able to investigate emotion matching while still accounting for initial baseline preferences for one emotional face over another. Consequently, the criteria for emotion matching might have been more stringent than those in past studies because infants would need to increase looking to a given face to a greater extent relative to baseline. Prior research has shown that subtle methodological differences, such as inclusion of silent trials, can impact intermodal matching of affect (Flom & Whiteley, 2013).

In addition, our stimulus durations were 10 s for each trial, whereas the trials from previously discussed emotion matching studies ranged from 1 to 2 min each. Studies showing stronger evidence of emotion matching with trial lengths similar to ours (Heck, Chroust, White, Jubran, & Bhatt, 2018; Vaillant-Molina, Bahrick, & Flom, 2013; Zieber, Kangas, Hock, & Bhatt, 2014) examined matching of voices to body expressions (Heck et al., 2018; Zieber et al., 2014) and matching faces and voices with only positive/negative contrasts (Vaillant-Molina et al., 2013), which might have facilitated infants' ability to identify the intermodal match. In combination, the brief trial length, multiple discrete emotions, and incorporation of a silent baseline trial may have made our task more challenging than the tasks in previous studies. In addition, it may be informative for future research to investigate whether these results extend to measures of expressivity from the primary caregiver alone rather than the full family environment. The Berkeley Expressivity Questionnaire (Gross & John, 1997) may be an informative measure for such future research because it asks detailed questions about an individual's own expressivity but may be difficult for an individual to answer with respect to others in his or her family.

It is also possible that the infants perceived our neutral stimuli as negative, increasing the emotion matching difficulty, particularly for the angry and sad conditions. We believe that this is unlikely given that adults did not identify our neutral stimuli as a discrete negative emotion any more often than they identified them as a discrete positive emotion (see Table 1). Nonetheless, it is possible that our infants may have perceived such stimuli differently due to less experience with negative and neutral emotions than our adult raters.

In conclusion, the current study makes a significant contribution to our understanding of emotion perception during infancy by identifying a significant positive relation between happy emotion matching and family expressiveness. This suggests that infants' immediate emotional environment may be directly related to early socioemotional development and, thus, may be an important factor to target when working to improve an infant's emotional development. Our data indicate that it is likely through exposure to various emotions that infants begin to match emotions across modalities, and this aids in the development of emotion perception.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jecp.2018.05.003.

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