Effects of Motion on Infants' Negativity Bias in Emotion Perception

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ABSTRACT

The negativity bias is a phenomenon that is characterized by infants being more influenced by, attending more to, and responding to more negative emotion information from the environment than positive emotion information. This study used a Tobii© T60 eye-tracking system to examine differences in 8- to 12-month-old infants' latencies to disengage from a centrally-presented face for three different emotion conditions-happy, sad, and fear. The events also varied by motion type-static versus dynamic. Additionally, infants' locomotor experience and parental affect served as two additional measures of experience, and assessed for their contributions to the infants' negativity bias. It was expected that infants would show longer latencies to disengage from the negative emotion events (fear or sad) compared to the positive emotion event (happy), but also that the latencies would be augmented by event type (dynamic > static), locomotion experience (high > low), and parental affect (higher negativity > lower negativity). Although infants showed more attention to dynamic than static emotion displays (especially on the speaker's mouth), and more attention to happy and sad compared to fear displays, no consistent effect of emotion type was found on infants' attention disengagement. Thus, no evidence for a negativity bias was seen. The results are interpreted with respect to possible contributions of the bimodal nature of emotion expression in the current study as well as age-related attentional differences in responding to a wide range of emotion cues.

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1.0 - Introduction

Within the period of human infancy (i.e., birth to the end of the first postnatal year), an impressive array of research findings support the view that even the youngest infant is sensitive to emotional information. That is, infants discriminate, recognize, and prefer sources of information that are in various ways termed “emotional.” Given the potential benefit of emotion processing for early social affiliation and mutual regulation (Locke, 2001; Mumme, Fernald, & Herrera, 1996), it seems reasonable to expect that infants are differentially sensitive to emotion valence, with more attraction to emotions deemed ‘positive’ (e.g., happiness, joy, surprise, soothing). In this light, young infants discriminate emotions and significantly prefer happy faces to fearful faces (Farroni, Menon, Rigato, & Johnson, 2007). However, in the second half of the first year, a surprising shift in emotion preference becomes evident. Infants start to show a negativity bias such as more attention toward fear and anger. Importantly, the behavioral measures of this negativity bias vary across studies and across ages, and the operationalization of an ‘emotion display’ is not always consistent.

The current study expanded this research literature by examining developmental changes in experiential factors that may lead to better understanding of the negativity bias during later infancy. The influences of self-produced motion (e.g., independent locomotion) as well as event motion (e.g., dynamic speakers) on infants’ ability to disengage from emotion displays were examined. Overall, it was predicted that self-produced motion would uniquely contribute to infants’ emergent selective attention to fear and sadness, and that this differential attention would be most evident when infants were viewing dynamic emotion displays (i.e., moving, speaking faces). To place this investigation within an empirical framework, evidence for infants’ emotion discrimination will be presented first, followed by a discussion of studies examining attentional bias (or ‘preference’) for emotions of a certain valence, as well as current conceptual accounts of why such a negativity bias might develop.

1.1 - Developmental Trajectory for Emotion Perception

Studies have shown that newborns are able to distinguish and prefer happy facial expressions to fearful expressions. However, newborns were either unable to distinguish or did not prefer fearful to neutral expressions (Farroni, Menon, Rigato, & Johnson, 2007). These authors suggest that newborns are indeed able to discriminate fearful and neutral expressions, but that they process them in the same way because of a lack of experience with fearful expressions. Kahana-Kalman and Walker-Andrews (2001) found that infants as young as 3.5 months old were able to recognize intermodal similarities between face and voice presentations of emotion expressions, but only when they were shown emotion expressions depicted by their own mothers. These infants also showed a preference for the happy condition over the sad conditions. The same effects, however, were not found when the emotion expressions were portrayed by an unfamiliar female. Taken together, familiarity with a range of emotion displays or the speaker appears to affect early emotion perception during infancy. However, as infants gain more experience, their attention to emotion information appears to generalize across some of these constraints.

In an eye-tracking study using static images of females expressing threat- and non-threat-related emotions, the scanning patterns of 4- and 7-month-olds were compared to adults (Hunnius, de Wit, Vrins, & von Hofsten, 2011). These authors found that all three age groups looked less at the inner features of the face when the threat-related expressions of fear and anger were displayed compared to neutral, sad and happy faces. Also, infants displayed fewer fixations on the eye regions of the face for the threat-related expressions compared to neutral and sad expressions (Hunnius, de Wit, Vrins, & von Hofsten, 2011). Such differential scanning patterns for the emotions used in this study suggests that young infants are capable of discriminating various emotions.

In a study with 5-month-old infants, Walker-Andrews and Lennon (1991) found that the infants could discriminate happy, sad and angry vocal expressions, but only when there was a face presented simultaneously. Infants failed to discriminate vocal emotions when the visual presentation was a checkerboard. Interestingly, for the infants to be able to discriminate, it did not matter if the female face affectively matched the audio presentation of emotion. Instead, it was sufficient for there to just be a face presented to the infants (Walker-Andrews & Lennon, 1991).

Infants from 4 to 7 months discriminated differences in dynamic, bimodally presented emotion expressions when they had been habituated to one emotion expression-happy, sad or angry-and then given a different emotion expression during the testing phase (Flom & Bahrick, 2007). However, in two additional experiments by the same authors, they found that only 5- to 7-month-olds were able to discriminate different unimodal auditory expressions of emotion, but only 7-month-olds were capable of discriminating different unimodal visual expressions of emotion. Also interesting to note is that in this particular series of experiments, the infants at the three different age groups did not show any preference for positive over negative emotion expressions (Flom & Bahrick, 2007). The authors suggest that the reason 4-month-olds were able to discriminate bimodally-presented emotion expressions is due to the intersensory redundancy and the temporal synchrony of the visual and auditory cues, not necessarily because there is simply more information available in the bimodal condition. The intersensory redundancy hypothesis posits that information presented in two sensory modalities concurrently and temporally-synchronously facilitates and elicits greater attention of amodal (e.g. rhythm, tempo) information than when this information is presented unimodally (Bahrick, Lickliter, & Flom, 2004). Therefore, intersensory redundancy enhances attention, perception and learning early in development (Flom & Bahrick, 2007).

It is not until infants are older (i.e., latter half of the first postnatal year) that they are able to respond appropriately to vocal-only emotion cues, as in a social referencing situation (Mumme, Fernald, & Herrera, 1996). In this study, mothers were told to express happy, fear, or neutral expressions in either a face-only or voice-only condition to their 12-month-old infants. Infants who were in the fear vocal-only condition approached a target toy fewer times, showed more negative affect, and looked at their mothers more compared to those in the neutral and happy vocal-only conditions. The same effects were not found for the fear face-only condition. The authors suggested that the face-only condition is not a strong enough signal to change the infants' behavior, but that infants were able to respond appropriately to the voice-only fear condition.

Taken together, the research presented thus far shows that there is evidence that even very young infants are able to discriminate, recognize, and show preferences for different emotions (Farroni, Menon, Rigato, & Johnson, 2007). Up to this point in development, research has shown that younger infants are able to discriminate positive from negative emotions, but it has also been shown that there are differences depending on the familiarity with the person expressing the emotion (Kahana-Kalman & Walker-Andrews, 2001).While the results have been somewhat mixed, there is evidence that there exists a positivity bias in infants in the first half of the postnatal year. However, a negativity bias begins to emerge in the second half of the postnatal year.

1.2 - The Negativity Bias: Infants' Attention to Negative Emotions

The negativity bias in infants is characterized as being more influenced by, attending more to, and responding to more negative emotion information from the environment than positive emotion information (Vaish, Grossmann, & Woodward, 2008). As mentioned previously, it appears that there is a positivity bias in early infancy, but that the negativity bias starts to emerge around the second half of the first year. In an ERP study by Peltola, Leppänen, Mäki and Hietanen (2009), 5 and 7-month old infants were exposed to fearful and happy faces using a visual paired comparison task. The authors found that 7-month-old infants displayed a greater allocation of attention to the fearful faces as shown by the larger negative central (Nc) component compared to the happy face, and they also looked longer at the fearful face compared to the happy face. Neither of these findings was evident in the 5-month-old group. One explanation for why the 7-month-old infants in this study allocated more attention to the fearful face than the happy face is that they were drawn more to the salience of the eyes in the fearful face.

In an eye-tracking study, Peltola, Leppänen, Vogel-Farley, Hietanen and Nelson (2009) examined 7-month-old infants' latency to disengage attention from fearful, neutral and happy faces using an overlap task. Moreover, to assess whether saliency of fearful eyes was the reason behind the greater allocation of attention over happy faces, fearful eyes were superimposed on a neutral face. Therefore, the emotion expressions were fearful, happy, neutral, and neutral with fearful eyes. With this manipulation, the authors found that infants took longer to disengage from the fearful face compared to the other three expressions, even the neutral expression with fearful eyes. Therefore, it is not just the fearful eyes, but the entire fearful face that is holding the infants' attention.

Grossmann, Striano and Friederici (2007) evaluated 7- and 12-month old infants in an ERP study to see if the infants showed an enhanced Nc response to an angry expression over a happy expression. They also used a preferential looking paradigm for the happy and angry expressions in order to explore the relation between ERP and behavioral data. Previous findings by Nelson and de Haan (1996) had shown that a fearful face elicited a greater Nc than a happy, but that there was no difference in the Nc between fear and angry expressions, which led to the prediction for this study that infants would show a larger Nc to an angry expression compared to a happy expression (Grossmann, Striano, & Friederici, 2007). Although the authors had hypothesized that the Nc would be greater for the angry face over the happy face for the 7-month-old, they actually found the opposite result. That is, infants showed a higher amplitude Nc to the happy expression than the angry expression, and that might be in part be due to inexperience with the signal value of the angry expression. The authors suggest that it is possible that 7-month-old infants perceive fearful and angry faces differently and not merely that both are negative.

Contrary to this finding with the younger age group, Grossmann, Striano and Friederici (2007) found that 12-month-old infants did show the expected larger posterior negativity to the angry over fearful face. The authors suggest that a developmentally-related experience between the period of 7 and 12 months alters the way the older infants perceive angry expressions. In the third experiment in the series, the authors compared the ERP data to looking behavior data. They found that both 7- and 12-month old infants looked longer at the happy faces over the angry faces, which suggests that the difference in the ERP data for the 7- and 12-month-old infants was not due to difference in visual preference.

Kobiella, Grossmann, Reid and Striano (2008) went a step further to see if 7-month-old infants could discriminate fearful and angry faces. In this ERP study, the infants were shown color photographs of the same woman displaying fearful and angry expressions in random order. They found that the average amplitude of the Nc was significantly greater for the angry expression over the fearful expression. This means that the infants were allocating more attention to the angry face than the fearful face. The findings suggest that 7-month-old infants are able to discriminate angry and fearful expressions.

Twelve-month-old infants have been found to show an increase in negative affect after receiving a negative signal from an adult, and are also more likely to interact and look longer at their caregivers, but not with the experimenter, after receiving a negative signal than they were when receiving a positive or neutral emotional signal from an adult. Infants who referenced the adult more quickly, as opposed to more slowly, when being exposed to a novel event had a bigger increase in ERP amplitude for the Nc component to negative emotional events (Carver & Vaccaro, 2007).

Although there is evidence to suggest that a negativity bias does exist in infancy, it is not known exactly *why* the negativity bias exists. Two general explanations center on whether a bias toward negative emotion explanation is expected in developing humans due to evolutionary value ('experience expectant') or some more proximate, developmentally-salient experience during infancy ('experience-dependent'). The first, the experience-expectant explanation is more evolutionary-based in that humans pay more attention to threat-related events, such as fearful and angry expressions, because it incurs survival value (Nelson, Morse, & Leavitt, 1979). That is, attending more to information pertaining to threat, or even perceived threat, increases the likelihood of escape, avoidance, or other like responses that act to decrease danger. On the other hand, the experience-dependent explanation is more learning-based in that humans are not born with a predisposition towards paying more attention to threat-related events, but they become more attentive due to experiences and increased familiarity with consequences of negative events and emotions. In their review, Leppänen and Nelson (2009) suggest that there is a life-long plasticity for processing of emotions that is dependent on a particular individual's experiences. Therefore, they suggest that individuals may be better at discriminating or recognizing certain emotions that they have frequently encountered due to perceptual narrowing. One developmental learning experience that has been implicated in the development of the negativity bias is that of self-locomotion (Vaish, Grossmann, & Woodward, 2008).

1.3 - The Emergence of Self-Locomotion

The period in which infants begin self-locomoting is an important time for their emotional development as well. In an experiment with crawling infants with 5 days of locomoting experience, precrawling infants with 5 days of artificial locomoting experience, and with infants with no locomotion experience, Campos, Bertenthal, and Kermoian (1992) found that any experience in locomotion leads to a fear or wariness of heights as demonstrated by significantly increased heart rate when being lowered on the deep side of the visual cliff. This wariness was not found in infants who did not have the experience of self-locomotion. In a second experiment by the same authors, infants with more experience in locomotion showed more avoidance behaviors to the deep side of the visual cliff than those with less experience, regardless of age of onset of locomotion.

Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, and Witherington (2000) found that mothers of infants who were locomoting reported that the mothers showed more negative emotions, particularly anger, in both their facial expressions and voices compared to when their infants were not locomoting. However, Karasik, Tamis-LeMonda, Adolph, and Dimitropoulou (2008) found that in a laboratory setting, mothers would use a mixture of positive and negative expressions when their infant was in a potentially risky situation, which the authors suggest is possibly because the mothers wanted to get across their message of warning without discouraging the infant. In the same study, mothers of experienced crawlers used more frequent and more diverse verbal communication than mothers of novice walkers (Karasik, Tamis-LeMonda, Adolph, & Dimitropoulou, 2008). In a similar study, Tamis-LeMonda, Adolph, Dimitropoulou and Zack (2007) found that mothers' warnings to infants in a potentially risky situation typically fell under the "basic prohibition" category, such as the mother saying "Stop!" or "Don't!" Another category of warning that was examined was that of attention-grabbers (e.g. the infant's name), which do not necessarily convey negativity. However, the authors suggest that the attention grabbers could be transformed into a warning due to the mother's tone of voice and frightened facial expression. This study also found that older infants, 18-to-24-months of age, get more frequent and more complex warnings per situation than the younger 12-month-old infants.

In addition to the emergence of self-locomotion between 6 and 9 months of age, infants are also undergoing changes in sensorimotor intelligence, object relationships, emotion knowledge and development, and importantly, continue to develop new ways to communicate in their social environment (Bertenthal, Campos, & Kermoian, 1994). As infants age and gain more self-locomotion experience, mothers vary the way that they communicate with their infants (Karasik, Tamis-LeMonda, Adolph, & Dimitropoulou, 2008). Emotions play an important role not only in how mothers use emotions to affect their infants' behavior, but, as will be discussed next, emotions can also enhance, or hamper, language development in infancy.

1.4 - Implications of the Negativity Bias for Language Development

Newborn and 1-month-old infants have been shown to prefer infant-directed speech (IDS) over adult-directed speech (ADS; e.g., Cooper & Aslin, 1990). More recently, however, it has been suggested that infants prefer IDS because it could be seen as being affectively positive or happy. Singh, Morgan and Best (2002) did a series of experiments to examine this possibility. In the first experiment, they replicated previous experiments using the more affectively happy IDS versus the more affectively neutral ADS and also found that 6-month-old infants preferred IDS over ADS. Next, they did another experiment with IDS and ADS with three types of affective characteristics: happy, neutral, and sad. The pitch range was greater for the happy and sad IDS than the neutral IDS and all three ADS conditions. The authors did not find a significant preference for IDS in any of the three conditions, but the overall looking times were less than that from the first experiment. This suggests that the infants only prefer IDS because it is more affectively positive, and when that is equalized among conditions, there is no preference.

In a third experiment, Singh, Morgan and Best (2002) found that infants prefer happy over neutral speech, regardless of whether or not it is IDS or ADS, when the speech register has been held constant. In a fourth experiment, the authors found that infants prefer happy ADS over neutral IDS as well as happy IDS over neutral ADS. Because it is not known if infants prefer affectively positive speech, or just emotionally expressive speech in general, in a fifth study, the authors tested for preferences in sad IDS and ADS over neutral IDS and ADS. They found that the infants significantly preferred to listen to neutral IDS over sad ADS, but there was a nonsignificant preference for neutral ADS over sad IDS. This would suggest that it is not the emotionally expressive speech in general that they are drawn to, but speech with positive vocal affect. The authors suggest that it is the positive affect that is actually drawing the infant's attention to speech, rather than the speech drawing attention to the expressed affect.

The auditory feature that is considered to be one of the key cues in discriminating emotions is vocal prosody (Grossmann, 2010). In a separate study, Trainor, Austin and Desjardins (2000) looked at the prosodic characteristics of IDS and ADS. They found that, like previously mentioned studies, mean pitch was higher for IDS than ADS, but they also found that the pitch changed relative to the expressed emotions of love-comfort, fear, and surprise. They did not find a difference in pitch contour, tempo, pitch range, or rhythmic contour between IDS and ADS, but each of these characteristics changed in both IDS and ADS depending on the emotion being expressed. However, love-comfort expressed in IDS was slower in tempo than love-comfort in ADS. The authors also suggested that the emotion prosody in IDS may help maintain infants' attention and help in language acquisition.

Singh, Morgan, and White (2004) examined 7.5-month-old infants recognition to tokens used in a familiarization procedure that were either happy or neutral in affect. The infants were first familiarized to two words, one that was happy in affect and the other neutral, and then they listened to passages that contained sentences using the familiarized words and passages that did not contain the familiarized words. The happy words were higher in minimum and maximum F_0, mean F_0, and pitch range compared to the neutral words. The happy passages were higher in pitch, minimum and maximum F_0, and had a greater proportion of high-frequency energy compared to the neutral passages. There were no differences in duration for the different emotions in either the tokens or the passages.

Singh, Morgan and White (2004) found that infants listened more to the happy passages than the neutral passages in the recognition task. They also looked longer when the passages had the happy token word in them than when they contained an unfamiliar word. The infants were able to recognize the familiarization words in the happy recognition passage when they were in the happy familiarization condition, but they were unable to recognize the familiarization word from the neutral condition. On the other hand, the infants were only able to recognize the familiarization word from the neutral condition, not the happy condition, when they had the neutral recognition passage. This suggests that the infants do not necessarily learn the target word when it is happy. Rather, they are able to recognize the word when it matches in affect with the familiarized word.

In a second experiment with 10.5-month-old infants, the Singh, Morgan and White (2004) found again that the infants listened longer when the passages contained happy familiarized words over unfamiliar words. The infants also had significant positive recognition scores for the words in the happy recognition passages that they were familiarized to in the happy condition. Overall, happy words were preferred over neutral and unfamiliar words, while neutral words were not preferred to unfamiliar words. However, the 10.5-month-old infants were not able to recognize neutral words unless they were in the neutral passages. In a third experiment, 7.5 and 10.5-month-old infants were familiarized to words only in neutral affect, and then heard passages with happy affect, thus simplifying the task compared to the first two experiments. After doing this, the authors found that 10.5-month-old infants were able to recognize the neutral familiarization words, but the looking times with the affectively neutral sentences were reduced. However, the 7.5-month-old infants were unable to recognize the neutral familiarization words in the happy passages. The authors suggested that infants continue to show a positivity bias for happy over neutral speech into the second half of the first year.

Walker-Andrews (1997) found related results in that 7-month-old infants who were exposed to faces and voices that were either affectively matched or mismatched looked longer when the affect was matched across face and voice. However, contrary to the suggestion of a continued positivity bias from the study discussed above, Walker-Andrews (1997) did not find a difference in preference for the happy or angry face, regardless of whether or not the voice matched affectively. These findings were obtained using faces with the mouth blocked so the infants were unable to obtain speech information from the mouth. Walker-Andrews (1997) repeated the same experiment with 5-month-old infants, but found that the younger infants did not show a preference for faces when the vocal affect matched. These infants still failed to show a preference for either the happy or angry expression, however.

One implication of the effect of negative emotion on both infants' language and socioemotional development comes from examining interactions between depressed mothers and their infants. Murray, Marwick, and Arteche (2010) found that having a depressed mother who expressed sadness in their "baby-talk" was a predictor for the offspring developing an affective disorder in adolescence. Rather than the typical infant-directed speech patterns, these mothers showed more of a narrowed range of pitch, increased frequency in falling pitch contours, and abnormal voice quality, leading the mothers' voices to sound monotone or flat (Murray, Marwick, & Arteche, 2010). Depressed mothers also tend to speak less in natural settings (Breznitz & Sherman, 1987).

Reissland, Shepherd, and Herrera (2003) found that depressed mothers had a higher overall pitch and more pitch modulations than nondepressed mothers when reading a story to their infants. The authors suggested that the pitch may be higher because the mothers felt stressed and the higher pitch may in turn stress the infant. Typically, reading storybooks allows infants and children to develop their language skills (Whitehurst et al., 1988), but if infants of depressed mothers find the experience unpleasant or unrewarding, this may explain why they speak less at 2.5-to-3.5 years of age (Breznitz & Sherman, 1987).

In a study examining whether 4-month-old infants of depressed mothers learn in response to their own mothers' IDS, Kaplan, Bachorowski, Smoski, and Hudenko (2002) found that these infants learned when listening to an unfamiliar nondepressed mother's IDS, but not when listening to their own mother or another depressed mother's IDS. Infants of nondepressed mothers were able to learn with their own mother's IDS and an unfamiliar nondepressed mother's IDS, but not a depressed mother's IDS. The authors proposed that infants of depressed mothers may have some of the negative effects on learning reduced if they are exposed to nondepressed caregivers. Without this, continued exposure to a depressed primary caregiver could lead to learning deficits later in life.

Kaplan, Burgess, Sliter, and Moreno (2009) found that 5.5-to 13-month-old infants of nondepressed mothers had stronger associative learning compared to infants of depressed mothers after taking into account demographics and antidepressant use in the depressed mothers. Contrary to previous studies, the authors did not find that the variability in F_0, or lack thereof in depressed mothers, predicted later infant learning. Rather, recordings of mother-infant free play showed that the infants of depressed mothers were less responsive to parental bids, and the depressed mothers were less sensitive and more hostile than nondepressed mothers. Due to low maternal sensitivity, the authors suggested that this may explain why IDS does not seem to be as effective in promoting learning in infants of depressed mothers compared to infants of nondepressed mothers.

1. 5 - Purpose of the Study

Among the criticisms of the current research that Vaish, Grossmann, and Woodward (2008) mentioned in their review of the negativity bias literature are measuring and accounting for infants' exposure and experiences with the different emotions being used in particular studies, looking more at the differences among the various negative emotions, and directly measuring infants' amount of locomoting experience.

The current study extends our knowledge about how infants perceive different emotions by expanding on current research regarding the negativity bias in attention to emotions. In this study, infants' latency to disengage from static vs. dynamic presentations of different emotion expressions toward a peripherally-presented distractor was used as an index of sustained attention. It was expected that if a negativity bias exists, it would be most evident in infants showing longer latencies to disengage from an adult female who is conveying a negative emotion compared to a positive emotion. Moreover, the current study focused on infants who are at the age where most had begun to crawl (Bertenthal, Campos, & Kermoian, 1994), up to the age where infants were transitioning from crawling to walking (Karasik, Tamis-LeMonda, Adolph, & Dimitropoulou, 2008). Locomotion experience was measured through parental report of the infant's locomoting abilities, such as being able to stand without assistance or crawling on hands and knees. Thus, a secondary goal of the current study was to assess whether degree of locomotor experience augments sustained attention to negative emotion displays.

Hypothesis 1a: Infants will show significantly longer latencies to disengage from an emotion display as a function of emotion type. Specifically, infants will show significantly longer latencies to disengage from fearful displays, compared to both sad and happy displays, and also will show significantly longer latencies to disengage from sad displays compared to happy displays (main effect of emotion).

Hypothesis 1b: Infants will show significantly longer latencies to disengage from dynamic events than from static events, independent of emotion type (main effect of condition)

Hypothesis 1c: Infants will show significantly longer latencies to disengage from an emotion display as a function of emotion type (Hypothesis 1a) to a greater degree when the emotion display is dynamic compared to static (Hypothesis 1b) (interaction between emotion and condition).

Hypothesis 2: Infants high in locomotor skill will show significantly longer latencies to disengage from negative emotions (fear and sad) compared to infants lower in locomotor skill (main effect of locomotion), but emotion type and locomotor skill will interact such that infants high in locomotor skill will show significantly longer latencies to fear compared to sad, but infants lower in locomotor skill will show no difference.

Hypothesis 3: Infants who have primary parents higher in negative emotion experience will show significantly longer latencies to disengage from negative emotions (fear and sad) compared to infants of primary parents lower in negative emotion experience.

1.6 - Contributions to the Literature

The findings from this study add to the existing literature by providing information about under what circumstances an infant may show a negativity bias. As previously mentioned, one explanation for why infants and adults show a negativity bias for fear is that it is an instinctual response to threat-related information. Because the negative emotion expression of sadness was used in addition to fear, this study was able assess that either infants at these ages show a negativity bias for negative emotions, regardless of whether or not they are threat-related, or if the bias is specifically for threat-related expressions of emotion. In addition to testing the threat-response explanation, this study also examined the experience-dependent explanation in which one of the mechanisms implicated is the onset of self-locomotion.

Finally, because this study used both static and dynamic bimodal events, it was possible to see how infants' attention to emotional expressions varied as a function of the informativeness of the display itself, providing further evidence for a need to use the more ecologically-valid multimodal, dynamic events rather than unimodal, static events when making interpretations about infants' emotional processing.

2.0 - Method

2.1 - Participants

The final sample consisted of 17 (10 female) 8-to-12-month old infants (mean age = 292 days; SD= 38 days). An additional three infants were tested, but were not included in the final sample due to fussiness (1), and inattention (2). All infants were healthy (by parental report) at the time of test. Infant and family information was obtained with a demographics questionnaire (Appendix A) from the caregiver at the scheduled appointment time. The participants were predominantly Caucasian (88%; 6% Asian, 6% Bi-racial/Other) and median household income was US $65,000. The median maternal education level was a master's degree, and the median paternal education level was a college degree. Demographics of the sample were representative of the surrounding geographic area. Of the final sample, 15 mothers completed the questionnaires and were considered the primary caregivers, and 2 fathers completed the questionnaires and were considered the primary caregivers.

Participants were recruited through a database maintained in the Developmental Research Suite in the Department of Psychology at Virginia Tech. This database included potential parents of infants obtained through a national mailing list (Info-USA), referrals from other parents involved in developmental studies, and respondents to advertisements placed throughout the community in day care centers, posted on university list-servs, and local newspapers. Parents either received an invitation letter, or (if they had previously participated in a developmental study) a phone call. Parents who indicated they were interested in participating with their infant were scheduled for a one-time appointment. There was no compensation for participation in the study.

2.2 - Materials and Equipment

Dynamic and Static Events.

Dynamic events consisted of short movie clips of two female speakers saying several phrases (see Appendix B) that varied in emotional tone (happy, sad, fear). In order to maximize the quality of facial/vocal emotion in these movie clips, the female speakers were recruited from HaeBo Theatre Productions, Summer Musical Enterprise, and New River Stage, which are local theater organizations. After providing consent (see Appendix C), participating actresses were filmed in a quiet room against a neutral-colored background, all wearing a black tunic to standardize the contrast against their head/neck area. They were filmed with a digital camcorder, using an external lapel microphone positioned close to their vocal tracts for increased vocal quality. The female speakers used in the events were only shown from the neck up with a grey background. The movies were in color, with all video editing done in Adobe Premiere©, and all audio editing done in Adobe Audition©.

The dynamic emotion movie clips were rated by undergraduate psychology students prior to testing to ensure that the target emotions were achieved. The students were asked to evaluate the emotion being expressed and the intensity of that emotion (see Appendix D). The clips with the highest percentage correct for identifying the emotion and with the highest emotion intensity were chosen for use as events in the study. Static events consisted of still images taken from the movie clips described above. The audio track from the associated movie clip was played conjointly with the static image in order to make a second array of movies in which the visual image did not move. Both the static and dynamic movie clips were approximately 20 sec in duration, and all voices normalized in volume. Playback to the infants was between 70-72 dB SPL (a level that is consistent with casual conversational speech).

The distractor event was a 2 in x 2 in square black and white checkerboard that appeared randomly in varying locations on the screen (e.g., top-left corner, bottom-right corner). Each movie clip (whether dynamic or static) only had one presentation of the distractor. The distractor appeared at random times for each clip after movie onset and remained on until the end of the clip. Varying both the location and timing of the distractor eliminated or greatly reduced the chance that the infant would be able to predict the onset and location of the target.

Eye-tracking Apparatus and Measures.

The apparatus used for this experiment was a Tobii© T60 eye-tracking system, which measured eye movements through the use of near infrared illumination (Tobii© Handbook). The Tobii© T60 Eye Tracker consisted of a 17" TFT monitor, which was connected to a Dell Optiplex 755 desktop computer and monitor. The Tobii© T60 had a built-in TET server which controlled all presentation of events to the viewer while simultaneously recording dual eye movements on the screen via a two-camera system. This dual camera system maintained calibration of eye position in spite of head movements that occurred during presentations.

There are several ways to examine eye movements, including saccades and fixations. Saccades are rapid movements that occur between pauses of eye movements in a specific position in the field of vision, which are fixations. Visual angles measure the accuracy of the fixation calculations and are represented by the following equation: opp = Tangent (A) x a (Tobii© handbook). This algorithm uses the angle of dispersion of the visual field in order to calculate the projection size. The visual angle of the foveal area of the eye where visual data is processed is between 1 and 2 degrees. Eye-trackers generally are accurate between 0.5 and 1 degree. In this case, a smaller angle measurement indicates better accuracy. Visual angles were calculated for both the centrally-presented face (17.86°) and the distractor (4.16°).

2.3 - Procedure.

After entering the laboratory, the infant and parent first interacted with the researchers in the infant waiting room. This allowed the experimenters and the infant to have a “warming up” period so that the infant and parent were comfortable prior to testing. While the infant played with toys with the researchers in the infant waiting room, the parent completed the paperwork (see Appendix A, E-G) in the same room. Once the parent signed the informed consent form and completed the paperwork, the testing period began.

The infant was seated in a highchair approximately 70 cm from the eye-tracker in the testing room. The lights in the testing room were dimmed in order to maximize the infant’s attention on the screen. Black curtains and an approximately 6’ x 6’ dividing screen blocked the rest of the room and computer equipment from the infant’s view. The infant’s parent sat in a chair next to the infant, and was instructed to not interact with the infant unless they began to fuss. A webcam enabled the experimenter to view the infant’s behavior during testing.

Calibration Procedure.

Calibration allowed for the measurement of the unique characteristics of each individual participant’s eyes. Each infant was calibrated first using a five-point calibration test with moving targets and sounds, which acted as an attention grabber for the infant. The background of the calibration screen matched that of the background of the events used in the test so as to provide the best quality of calibration. Once the infant was looking at the screen, the right arrow on the keyboard was pressed to start calibration. The target appeared in one area of the screen until the right arrow was pressed to advance the target to the next location. This sequence was repeated until all five points were shown. The calibration plot then appeared on the experimenter’s screen for each of the five target locations. The quality of calibration was shown using error vectors, which represented the offset from the gaze point data to the calibration target. If the dispersion from the center of the target was substantial and/or there was no data for a particular point, those points were recalibrated until the calibration was an acceptable quality. Following calibration, the test began.

The order of the test events were randomized with constraint for each emotion (happy, sad, fear) and condition (dynamic, static) in a block, such that no emotion and no condition occurred more than twice in succession. Initially, all emotion x condition events occurred once per block, across three blocks of trials, for a total of 18 total events. The task sequences were counterbalanced across participants.

Between each individual trial, a target with a white “X” with a red a circle around it was presented for two seconds to focus the infant’s eyes on the center of the screen. In order to increase infants’ engagement with the task, short movie clips approximately 20 seconds in length of a popular cartoon were shown after every three events. The length of the task took less than fifteen minutes, including both the calibration and testing periods. If the infant started to cry, fell asleep, or was otherwise not watching the task after several attempts to regain attention to the monitor, the task was stopped. The entire appointment took approximately one hour.

2.4 – Measures.

Locomotion Measure.

The locomotion measure (Appendix F) used in this study comes from the gross motor skills subdomain on the Vineland-II (Sparrow, Cicchetti, & Balla, 2005). This measure was included due to its wide acceptance in the field, in addition to its good internal consistency and test-retest reliability. The questionnaire booklet was used with the parent answering the questions. The first age block of the Vineland-II was used, which includes from 0-12 months, therefore 15 total items were answered by the parents for this sample of infants.

Parental Affect Measure.

In order to obtain some general measure of parental affect, a modified version of the Positive and Negative Affect Schedule-Extended Form (PANAS-X; Appendix G) was administered to the parent. The PANAS-X (Watson & Clark, 1999) is an expanded version of the PANAS, which originally contained just two higher order scales: positive affect and negative affect. The PANAS-X goes beyond these two scales and adds an additional 11 specific affects, of which only four were used in the current study. The scales used included the original positive and negative affect scales, in addition to the fear, sadness, joviality, and attentiveness scales. Seventeen items fell on the negative affect dimension, and 17 items fell on the positive affect dimension. The parent was asked to identify how he or she feels on average for each of the items using a Likert-rating scale of 1 (very slightly or not at all) to 5 (extremely). To score the PANAS-X, each individual respondent's 17 positive items were summed for an overall positive score, and the 17 negative items were summed for an overall negative score. For the 17 parents who completed the PANAS-X, the positive scale had a mean score of 63 (*Min*=45; *Max*=80), and the negative scale had a mean score of 28 (*Min*=17; *Max*=51).

The PANAS-X has been demonstrated to have good test-retest reliability, shows significant discriminant and convergent validity, and is positively correlated with other measures of affect, personality, and emotionality. For test-retest reliability, the scores ranged from 0.55 to 0.64 for the general instructions. For the discriminant validity measures, the scores for the fear scale compared to the joviality, attentiveness, and sadness scales ranged from -0.02 to 0.13, respectively; the scores for the sadness scale compared to the joviality, attentiveness and fear scales ranged from -0.13 to 0.15; the scores for the joviality scale compared to the attentiveness, fear, and sadness scales ranged from 0.00 to 0.17; and the scores for the attentiveness scale compared to the joviality, fear and sadness scales ranged from -0.06 to 0.15. The convergent correlations for self vs. peer ratings ranged from 0.21 to 0.36 for the scales being used in this study. The convergent correlations with a peer rating measurement, the Profile of Mood States (POMS) Scales, ranged from 0.85 to 0.91 (Watson & Clark, 1999).

3.0 - Results

The following analyses were calculated using a final sample of 17 infants, and represent response patterns from only the first block of trials. The remaining two blocks were not included in the final analysis due to a noticeable reduction in both the quality and quantity of infants' eye scanning activity (e.g., many trials in Blocks 2 – 3 with < 50% gaze activity). Also, there were no significant gender differences, therefore the following analyses were collapsed across this variable. The descriptive statistics and a summary of the following analyses can be found in Tables 1 and 2.

3.1 - Gaze Pattern Analyses

Although latency to look at the distractor was the primary variable of interest, the first analyses were conducted on infants' gaze patterns on the faces of the actresses given that eye tracking provides information about the number and duration of fixations on specified areas of interest. Analyses were performed to see if there were differences across the various display types for fixation data. Fixation duration is the average total amount of time infants fixated within a particular area of interest (AOI) during each event, whereas fixation count is the average total number of times the infant fixated within an AOI during each event. AOIs were drawn for the whole face ("Face"), upper-half of the face ("Eyes"), and the lower-half of the face ("Mouth"). The Face AOI was drawn to include everything from the hairline to the jawline. The Eyes AOI was drawn to include everything from the hairline to the top half of the nose. The Mouth AOI was drawn to include everything from the bottom half of the nose to the jawline.

3.2 - Fixation Duration

A 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) repeated-measures ANOVA was conducted on the total fixation duration to the face to get a general measure of attention across display types. Although the main effect for emotion was not significant ($F(2,32)=2.74$, $p>.05$), there was a significant main effect of condition, $F(1,16) = 17.82$, $p=.001$; $\eta^2_p=0.53$), such that the fixation duration to the face in the dynamic condition (*M*=9.52, *SD*=5.29) was significantly longer, $t(16)=4.22$, $p=.001$, compared to the static condition (*M*=5.98, *SD*=2.40). Figure 1A shows the main effect for the fixation duration to the face by condition type.

Although the condition x emotion interaction was not statistically significant ($F(2,32)=1.45$, $p>.05$), I explored pair-wise differences in the amount of time spent on the fearful, dynamic face compared to both the dynamic sad and happy faces given the general interest in how negative emotions affect infant attention. Interestingly, the mean fixation duration on the fearful, dynamic face (*M*=7.60, *SD*=5.23) was less than the amount of time spent on either the sad (*M*=10.52, *SD*=6.67; $t(16) = 2.88$, $p=.01$) or happy dynamic (*M*=10.45, *SD*=6.62; $t(16)=1.85$, $p<.09$) faces, but the mean fixation duration on the face between sad and happy emotion displays did not differ.

Next, to look more specifically at where on the face infants were directing their attention, a 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) x 2 (AOI: Mouth, Eyes) repeated-measures ANOVA was conducted. Overall, there was a significant main effect of condition, $F(1,16) =11.86$, $p<.01$, $\eta^2_p=0.43$, superseded by a significant condition x AOI interaction, $F(1,16) = 5.16$, $p < .05$, $\eta^2_p=0.24$. Pairwise differences were examined, and the mean looking duration in the mouth area in the dynamic condition (*M*=6.13, *SD*=4.86) was significantly greater, $t(16) = 3.49$, $p<.01$, than the mean looking duration in the mouth area in the static condition (*M*=3.10, *SD*=1.98; see Figure 2A).

3.3 - Fixation Count

A 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) repeated-measures ANOVA was conducted for the average fixation count to the face to get a general measure of attention across display types. There was a significant main effect of emotion, $F(2,32) = 3.66$, $p<.04$, $\eta^2_p=0.19$, such that the number of fixations to the sad face (*M*=17.09, *SD*=8.72) was significantly greater, $t(16)=3.94$, $p=.001$, than the number of fixations to the fearful face (*M*=12.91, *SD=7.12*). The number of fixations to the happy face (*M*=16.59, *SD*=8.22) was not significantly greater, $t(16)=2.02$, $p=.06$, than the number of fixations to the fearful face, and there was no difference between the number of fixations to the sad face compared to the happy face, $t(16)=-0.25$, $p>.05$. The main effect of emotion for fixation count is depicted in Figure 1B.

Next, to look more specifically at where on the face infants were directing their attention, a 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) x 2 (AOI: Mouth, Eyes) repeated-measures ANOVA was performed for the fixation count. There was a significant main effect of emotion, $F(2,32) = 3.42$, $p<.05$, $\eta^2_p=0.18$. A paired samples t-test was analyzed, where the number of fixations on the sad display (*M*=8.60, *SD*=4.46) was significantly greater, $t(16)=4.31$, $p=.001$, than the number of fixations to the fearful display (*M*=6.53, *SD*=3.78). There were no other significant differences in mean number of fixations across emotions.

In addition to the significant main effect of emotion, there was also a significant condition x AOI interaction (see Figure 2B), $F(1,16) = 5.12$, $p<.04$, $\eta^2_p=0.24$. There were significantly more fixations on the mouth AOI in the dynamic condition (*M*=8.75, *SD*=5.40) compared to the static condition (*M*=6.20, *SD*=4.17; $t(16) =3.19$, $p<.01$).

3.4 – Latency

The primary measure of interest for this study was infants' latency to disengage from a central emotion display to a peripherally-presented distractor. The latency to disengage was calculated from the raw gaze data file, which was reported in 15-millisecond (ms) increments. The distractor area of interest (AOI) was designated as either inactive (distractor not present), active-no hit (distractor present but no eye movement), or active-hit (distractor present and eye movement) in the raw data. If there was a "hit" on the distractor (i.e, an eye movement to the AOI occurred), the latency was calculated as the timestamp for the first hit minus the timestamp for the onset of the distractor. If there was no hit on the distractor during the event, the latency was entered as the maximum time (14,598 ms) across the events that the distractor was active.

As stated above, the primary hypothesis was that infants would show significantly longer latencies to disengage from an emotion display when the emotion valence was negative (fear or sad) than when it was positive (happy), and that latencies to disengage from dynamic displays (independent of emotion) would be longer than those to static displays. To test these predictions, a 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) repeated-measures ANOVA was conducted on latency measures[1] (see Figure 3A), but no significant main effects for emotion ($F(2,32) = 0.16$, $p > .05$), or condition ($F(1, 16) = 0.06$, $p > .05$), or their interaction ($F(2,32)=1.06$, $p > .05$).

An additional hypothesis was that the latency to disengage from negative emotions (fear or sad) would be longer for infants with more locomoting experience compared to those with less experience. A median split was performed on the raw scores from the Gross Motor subscale on the Vineland-II. All scores falling below the median (19) were labeled as the low locomotor group (n=8), whereas all those over the median were labeled as the high locomotor group (n=9).

The mean raw score on the subscale was 18.29 (*SD*=4.97). A 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) x 2 (Locomotion: Low, High) mixed ANOVA was conducted with condition and emotion as within-subject factors and locomotion as the between-subjects factor. There were no significant main effects of emotion ($F(2, 30)=0.11$, $p>.05$), condition ($F(1,15)=0.03$, $p>.05$), or locomotion ($F(1,15)=0.89$, $p>.05$). There was also no significant Emotion x Locomotion interaction ($F(2,30)=1.79$, $p>.05$) or significant Condition x Locomotion interaction ($F(1,15)=1.26$, $p>.05$).

The final hypothesis was that the latency to disengage from negative emotions would be longer for infants whose parents scored higher for negative affect than those infants whose parents scored lower for negative affect on the PANAS-X. These scores ranged from 17 to 51, out of a possible range of 17 to 75; thus, the sample was skewed toward low-to-moderate negative affect. Given that the mean was 28 (*SD*=10.01) and the median was 25, the sample was divided by those scores below or equal to the mean (lower negative affect; n=11) and those above the mean (higher negative affect; $n = 6$). A 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) x 2 (Negative Parental Affect: Low, High) mixed ANOVA was conducted with condition and emotion as within-subject factors and parental negative affect as the between-subjects factor. There were no significant main effects of emotion ($F(2, 30)=0.17$, $p>.05$), condition ($F(1,15)=1.18$, $p>.05$), or negative parental affect ($F(1,15)=0.88$, $p>.05$), and there was no significant Emotion x Negative Parental Affect interaction ($F(2,30)=0.02$, $p>.05$). However, there was a significant Condition x Negative Parental Affect interaction ($F(1,15)=7.64$, $p<.02$, $\eta^2_p=0.34$; see Figure 3B). Follow-up tests revealed that infants in the higher parental negative affect group (M=6722.61, SD = 4117.45) had significantly longer latencies to the distractor in the dynamic condition compared to infants in the lower parental negative affect group (*M*=3037.33, *SD*=3081.7; $t(15)=2.10$, $p = .05$). No other paired comparisons were significant.

3.5 - Other Latency Measures

As discussed above, some infants did not look at the distractor during a given condition, and thus were 'dummy' scored with the maximum distractor duration in order to contribute to the analyses examining relationships between event characteristics and disengagement. It was informative to look at differences across the conditions to see if non-looks to the distractor were more prevalent in one particular emotion or event type compared to the others. It was also important to look at the latency data for those infants who did look at the distractor to see if there were relationships between emotion type and condition.

There was at least one infant who did not look at the distractor during one or more events. Descriptively, the pattern of not looking at the distractor by event type was as follows: fear dynamic condition = 5 (29.4%); fear static condition = 2 (11.8%); happy dynamic condition = 2 (11.8%); happy static condition = 3 (17.6%); sad dynamic condition = 3 (17.6%); sad static condition = 1 (5.9%). Overall, there were more non-lookers in the dynamic conditions (n=10; 59%) than in the static conditions (n=6; 35%) across emotions.

Given that some infants always looked at the distractor, a separate 2 (Condition: Dynamic, Static) x 3 (Emotion: Happy, Sad, Fear) repeated-measures ANOVA was conducted on latencies for only these infants (n=8). However, there was no significant main effect for condition ($F(1,7)=4.79$, $p>.05$) or emotion ($F(2,14)=0.224$, $p>.05$), and no significant Condition x Emotion interaction ($F(2,14)=0.52$, $p>.05$).

3.6 - Correlational Analyses

Pearson correlations were performed to address the relationship between the various questionnaires (e.g. the positive and negative scales on the PANAS-X; see Table 3) as well as their relationships with the outcome measures for latency, fixation duration, and fixation count. The correlations between the questionnaires and the latencies for each event type can be found in Table 4. There was a significant, negative correlation between infant age and latency in the static, fear condition (r= -.50, p<.05), as well as the static, sad condition (r= -0.55, p<.05).

The correlations between the questionnaires and fixation duration to the face, mouth and eyes in each event type can be found in Tables 5A, 6A, and 7A, respectively. Overall, there were significant, positive correlations between infant age and fixation duration on both the face (r=0.55, p<.05) and mouth (r=0.61, p<.01) in the static, sad condition and the mouth in the static, fear condition (r=0.52, p<.05). Although it was not significant, the same positive relationship (r=0.46, p=.06) was found for infant age and fixation duration on the dynamic, sad mouth.

The correlations between the questionnaires and fixation count to the face, mouth, and eyes for each event type can be found in Tables 5B, 6B, and 7B, respectively. There was a significant, positive correlation (r=0.48, p=.05) between infant age and the number of fixations on the face in the dynamic, fear condition. In addition, there was a significant, positive correlation between infant age and the number of fixations on the mouth in the static fear emotion display (r=0.58, p<.05) and the static sad emotion display (r=0.66, p<.01). There was also a significant, negative correlation (r= -0.50, p<.05) between locomotion (i.e., raw score on the Vineland-II Gross Motor subscale) and the number of fixations on the eyes in the static, happy condition.

4.0 - Discussion

The primary hypotheses for this experiment were generated in response to an increase in interest in the development of the negativity bias in infancy, a phenomenon in which "infants attend more to, are more influenced by, and use to a greater degree negative rather than positive facets of their environment" (Vaish, Grossmann, & Woodward, 2008, p. 383). This negativity bias would be evident in several different aspects of attention, in particular, sustained attention and attention disengagement. The current experiment examined sustained attention through gaze analyses for both the duration and number of fixations to the emotion displays, where greater looking times and numbers would be indicative of more sustained attention to the centrally-presented emotion display. Attention disengagement was measured as a function of the latency to disengage from an emotion display and shift attention to a peripherally-presented distractor. Slower attention disengagement would be seen with longer latencies to look at the distractor once it has been presented. Additionally, two experience-dependent variables, self-locomotion experience and exposure to negative parental affect, were examined for their roles in the development of the negativity bias in infancy.

4.1 - Gaze Pattern Analyses

Given that infants were expected to take longer to look at the distractor in the fear and sad emotion displays compared to the happy display, this would presumably have been due to an increase in attention to the negative emotion display. In fact, the opposite was found: in the dynamic condition, less time was spent on the fearful display than either the happy or sad displays. There were also significantly fewer overall fixations to the fearful display compared to the happy or sad display, suggesting that it is not that the fearful emotion expression is capturing and maintaining infants' attention more than the happy and sad emotion expression, but rather that the infants are looking away altogether when the fearful emotion expression is present.

This interpretation of the current findings would be in line with the experience-expectant threat-aversion hypothesis suggested by Hunnius et al. (2011), in which infants would be expected to avoid threat-related emotions (e.g. fear and anger) but not non-threat-related emotion (e.g. happy and sad). This is in direct opposition, at least for the *increased attention* aspect, to prior research supporting the negativity bias (e.g. LoBue & DeLoache, 2010; Peltola et al., 2009), which has found a greater amount of time looking at a fearful face compared to a happy face. However, most research in this field has relied on static, unimodal events (for example, see Hoehl, Palumbo, Heinisch, & Striano, 2008; Hunnius et al., 2011; Kobiella et al., 2008; LoBue & DeLoache, 2010; Peltola et al., 2009; Peltola, Leppänen, Palokangas, & Hietanen, 2008).

Although the current findings did not replicate the prior research mentioned previously, they were in line with the findings of an experiment by Hunnius et al. (2011) in which infants were shown five different emotion expressions (happy, sad, fear, angry, neutral) using static, color images. These were categorized as either threat-related (fear and angry) or non-threat-related (happy, sad, neutral). They found that for their sample, significantly less time was spent on the inner features of the fearful face compared to the happy and sad faces. In addition, there was significantly less time spent looking at the eyes for the fear condition compared to the happy or neutral condition.

One interesting finding from the current study is that infants' age and locomotion experience were correlated with emotion, particularly negative emotion, on several of the measures. When infants viewed a dynamic fear display, there was a positive correlation between age and the number of fixations to the face area. In addition, infants who were older looked at the mouth in the static fear display more often. Older infants also fixated longer and fixated more often on the mouth in the static sad display. One final interesting relationship was that infants who scored higher on the locomotion measure (i.e. the high locomotors) looked fewer times at the eyes in the happy static display.

4.2 - Latency

In the present study, a propensity to attend more to negative information, in this case negative emotion expressions, would be evidenced by infants' longer latencies to disengage from the centrally-presented face to a peripherally-presented distractor as a function of the emotion being conveyed. Specifically, latencies would be longest for the fearful display compared to the happy or sad displays, as well as longer latencies to disengage from a sad display compared to a happy display. However, this prediction was not supported as there were no statistical differences in latency across the three emotions.

An additional hypothesis was that infants would show significantly longer latencies to disengage from dynamic events than from static events, independent of emotion type. Again, this was predicted due to the expectation that a dynamic face + voice display would be more engaging, and therefore infants would take longer to look away from the dynamic face + voice display compared to a static face + voice display. However, this hypothesis was also not supported by the results from this study. There were no significant differences in latency to disengage across the two conditions.

It was also expected that infants would show significantly longer latencies to disengage from an emotion display as a function of emotion type to a greater degree when the emotion display is dynamic compared to static. This would be an interaction between the first two hypotheses. This was predicted due to the expectation that, for example, a dynamic, fearful emotion display would be more salient and attention-grabbing to infants compared to a static, fearful emotion display. However, like the predicted main effects of emotion and condition, the interaction of these effects was also not significant. Therefore, this hypothesis was not supported by the experiment. Interestingly, however, correlational analyses found that the older the infants were, the shorter the latencies were to look at the distractor in both the static fear and static sad emotion displays. This could be due to a general reduction in attention to static displays of emotion as the infants get older, but there was not a significant correlation with age and the latency to look at the distractor for the static happy display. As such, it may be something specific about the negative emotions, both fear and sad, that leads older infants to disengage faster than younger infants.

The following two hypotheses dealt with two experience-dependent explanations for what may impact the development of the negativity bias. One of the reasons given for why the development of the negativity bias is that it seems to coincide with the emergence of *self-locomotion*, such that self-locomoting infants would have been exposed to fearful facial expressions and therefore would recognize the value of threat-relevant cues. As such, it was predicted that infants higher in locomotor skill would show significantly longer latencies to disengage from negative emotions (fear and sad) compared to infants lower in locomotor skill, but emotion type and locomotor skill would interact such that infants higher in locomotor skill would show significantly longer latencies to fear compared to sad, but infants lower in locomotor skill would show no difference. However, like the previous hypotheses, there were no significant differences between the high and low locomotor groups or within groups in regards to latencies to disengage from a fearful emotion display compared to a sad emotion display.

The second experience-dependent explanation explored in this study concerns infants' exposure to *negative parental affect*. It was expected that infants who had primary parents higher in negative emotion experience would show significantly longer latencies to disengage from negative emotions (fear and sad) compared to infants of primary parents lower in negative emotion experience. It was expected that infants who have more exposure to negative affect would, again, be able to respond to the cues embedded within negative emotion expressions. This hypothesis was partially supported in that infants in the higher parental negative affect group showed longer latencies to disengage in the dynamic conditions collapsed across emotions. Although it was expected that this difference would be most evident for the fear displays, it is interesting nonetheless that infants whose parents report more negative emotional experience actually conveyed more vigilance on the dynamic displays – in some sense, an emotion bias although not restricted to just negative expression.

Overall, the predictions with regard to the negativity bias (as measured by the latency to disengage from a centrally-presented face) were not supported. There are several explanations for why the results were not in line with prior research. One explanation is prior demonstrations of infants' negativity bias may be restricted to studies using static, unimodal images. When using dynamic, bimodal emotion expressions, no differential effect on attention disengagement was found as a function of negative vs. positive emotion displays. However, due to the lack of looking at the distractor in at least one condition for nearly half of the infants, it is difficult to interpret the latency measures with regards to whether they are or are not in line with the expected results. Importantly when only the infants who looked at the distractor were considered, there were still no significant effects found of emotion type on speed of attention disengagement.

In spite of the negative effect of emotion type on latency measures, it was interesting to note that nearly 30% of the sample did not look at the distractor at all during dynamic fear displays – perhaps some evidence for a negativity bias. A similar study to this one which used static images of happy and fearful faces had a similar finding, where the probability of making a saccade directed towards a peripheral-distractor was significantly less for the fearful face than the happy face (Peltola, Leppänen, & Hietanen, 2011).

Although studies finding support for a negativity bias have interpreted this finding as a possible novelty effect (Nelson & Dolgin, 1985), one recently showed that infants had difficulty disengaging from a fearful face to a distractor compared to a happy face as well as other novel facial expressions (e.g., a woman puffing out her cheeks, so that her face was distended; Peltola et al., 2008). In the current study, sadness was used as an additional emotion so that there was a way to compare infants' looking behavior to the fearful emotion display to another negative emotion expression. Like the Peltola et al. (2008) study, the findings from this study also had a higher instance of infants not looking at the distractor during the fear condition compared to the happy and sad (or novel emotion expression) conditions. Therefore, it would seem that there is something different about a fearful emotion display compared to other negative or novel emotion display.

Not surprisingly, the experience-dependent variables of locomotion and parent negative emotion were not able to differentiate patterns of infants' processing of emotion type. Unfortunately, there was constrained variance in the scores for both measures, and especially so for locomotion. For the parental affect measure, it could be that the reported scores on how the parents felt on average were not indicative of the emotions they actually expressed to or in the presence of their infants. It may be better to use measures that look at how parents react to infants in self-locomotion situations, such as with a live parent-infant interaction during a laboratory motor task similar to what was used in Karasik, Tamis-LeMonda, Adolph, and Dimitropoulou (2008).

It may also be that the negativity bias was not found in this experiment when it has been found in others is because the age range used for this study was older (c.f. Hoehl et al., 2008; Kobiella et al., 2008; Peltola et al., 2011). It could be that for the older infants, any dynamic face (positive or negative) would be equally as interesting. However, the correlational analyses showed that there was actually a positive relationship between age and both fixation duration and count to fear and sad emotion displays, but not to happy emotion displays. Therefore, as the infants' age increased, so did their attention to the fear and sad emotion displays. In addition, the correlational analyses demonstrated that latencies to disengage from the negative emotions, at least in the static condition, were negatively correlated with infant age such that the older infants were, the shorter their latencies were to disengage from a centrally-presented face to a peripherally-presented distractor. However, one of the features of the negativity bias is that it supposedly is maintained throughout adulthood once it has developed (Vaish, Grossmann, & Woodward, 2008). Therefore, it may be that the age range was too wide, such that the younger infants in the sample were not showing a negativity bias yet or are in a transition phase, but the older infants were showing a negativity bias. Therefore, it may be beneficial to examine an older sample of infants with more variability in both self-locomotion abilities as well as exposure to more varied emotion expressions.

Another reason the current experiment may have failed to replicate prior findings with regards to the latency measures is that, although this study used both dynamic and static events, both conditions were bimodal due to the inclusion of an audio-track. Therefore, it may be that the addition of the audio-track to the static images was enough to change infants' attention disengagement from the face in each of the emotion displays compared to a static image alone so that there were no differences across the emotions. It is difficult to say if this is the case though because there was not a silent condition included in this experiment. However, there was significantly less attention to the face in the static condition compared to the dynamic condition for all three emotions, so if there is a difference compared to using unimodal events, it is not to the point that the amount of attention to a static, bimodal event is equivalent to a dynamic, bimodal event.

4.3 - Event Motion

As discussed above, an overwhelming number of studies (for example, see Hoehl et al., 2008; Hunnius et al., 2011; Kobiella et al., 2008; LoBue & DeLoache, 2010; Peltola et al., 2009; Peltola et al., 2008) use only static, unimodal events, rather than dynamic, multimodal events. This is not limited to studies on the negativity bias in infancy (e.g. Farroni et al., 2007), but it is particularly important to consider how having multiple modalities, as in this experiment, may affect the looking patterns of infants. In addition to having multiple modalities, both audio and visual, the current experiment also used both static and dynamic events. This is not typical for the field, as many studies examining emotions use static images as their sole stimuli. This creates concerns with regards to the ecological validity of the findings. It may be the case that infants look longer at fearful faces when they are static, but is that still the case when the faces are moving?

It is clear based on the fixation duration data from this study that the type of event motion matters. There was significantly more attention overall to the emotion displays in the dynamic condition compared to the static condition. The main finding here was that the use of both static and dynamic events in this study demonstrated a clear difference in overall attention to each event motion type, particularly with regards to the amount of the attention focused on the mouth in the dynamic condition compared to the static condition.

4.4 - Social Referencing

There is an extensive amount of research regarding the transmission of emotion cues from parent to infant in laboratory studies, particularly with regards to novel objects (for review, see Vaish et al., 2008) and situations such as the visual cliff (Sorce, Emde, Campos, & Klinnert, 1985; Vaish & Striano, 2004).

In an ERP study using pictures rather than a live interaction, Hoehl and Striano (2010) presented pictures of fearful and neutral faces to 6- and 9-month-old infants. These faces were either gaze towards an object or averted away from an object that was presented simultaneously with the face. When the object was presented alone, it was found that for 6-month-olds, there was an enhanced Nc amplitude for objects that had been paired with the fearful face gazing towards the object. A similar study by Hoehl et al. (2008) found the same enhanced Nc (i.e., the ERP component most associated with selective attention) for 7-month-olds to objects that had been paired with a fearful face with gaze directed towards the object. However, for 9-month-old infants, the amplitude to the object associated with the neutral face was larger compared to the fearful face, but again only when the gaze had been directed towards the object. The authors suggest that this is evidence that infants who are too young to show the typical behaviors associated with social referencing tasks are able to pick up on social cues regarding threat-related information (Hoehl & Striano, 2010). Therefore, even using static images in this instance provided ostensive cues in the form of object-referential emotion expressions (Gergely, Egyed, & Király, 2007), fear versus neutral affect, to the infant. This, in turn, affected infants' attention to the object with respect to the emotion that had been conveyed towards the object (Hoehl et al., 2008; Hoehl & Striano, 2010).

In a powerful example of how emotion cues affect infants in ambiguous situations, Sorce et al. (1985) first compared how 12-month-old infants reacted to their mothers' facial expressions, happiness and fear, which were displayed when the infants referenced them before crossing the deep-end of a visual cliff. They found that none of the infants who were assigned to the fear condition crossed the visual cliff. On the other hand, most of the infants whose mothers displayed a happy facial expression did cross the deep-end of the cliff. An additional manipulation had mothers displaying a sad facial expression, which led to some infants, but not the majority, crossing the deep-end. The authors found a significant difference between the number of infants who crossed in the fear condition and the number of infants who crossed in the sad condition.

In a further manipulation of the visual cliff paradigm, Vaish and Striano (2004) compared infants' crossing behaviors depending on the modality of the mothers' displays (Voice Only, Face Only, Face + Voice). Mothers only expressed positive emotions in this particular experiment, but there were still significant differences in the measures of interest, crossing time and infant looking. They found that the crossing time was much faster in the bimodal Face + Voice condition compared to the unimodal Face Only condition. However, there was no difference in crossing time for the Face + Voice condition compared to the Voice Only condition. Infants also referenced the mother a greater number of times in the Face + Voice condition compared to the Voice Only condition (Vaish & Striano, 2004). Both of the measures demonstrated that the use of bimodal information affected infants' behavior (consistent with the results of the present study), and that the use of unimodal visual cues did not alter infants' behavior. Therefore, this is additional evidence that the use of static, unimodal events is not the most effective way to examine infants' behavior.

Although the previous example (Vaish & Striano, 2004) does show that audio cues can affect infants' behavior during social referencing paradigms, it was not just the use of an audio track that led to a difference among emotions for the fixation measures in the current experiment. There were no significant differences between the emotions in the static condition, which, like the dynamic condition, also had an audio track. If it was merely that the events were bimodal rather than unimodal that primarily made the difference, then similar results should have been found for both the static and dynamic events in this experiment because both were bimodal. However, that was not the case in this experiment. This would suggest that it is the dynamic visual aspect of emotion displays driving the differences in behavior.

In a recent study, Lewkowicz and Hansen-Tift (2012) examined how infants' selective attention to the face changes across the second half of the first year. They also used dynamic events, one with infant-directed speech and one with adult-directed speech. They found that the youngest group of infants, the 4-month-olds, looked significantly longer at the eyes compared to the mouth. The 6-month-old group looked an equal amount at the mouth and eyes. However, there was a shift in looking for the 8- and 10-month-old groups, such that they looked significantly longer at the mouth than the eyes. Finally, the 12-month-old group decreased looking from the prior level so that the amount of looking to the mouth and eyes were once again equal. The current experiment, which combined the results for the 8- to 12-month-old infants, did not find a significant main effect for AOIs for either fixation duration or fixation count. However, it may be that because all of the infants were analyzed together across the age range for this study, the differences in looking patterns were not detected.

5.0 - Conclusions

Overall, although the primary hypotheses were not supported with regards to the attention disengagement aspect of the negativity bias, there were still several important findings. The main finding from this study is that dynamic, multimodal events should be used instead of static, unimodal events. Infants' overall attention clearly seems to be enhanced when the events are moving. In addition, it may be that the negativity bias is only seen with the use of unimodal, static images since there were no significant differences in the predicted directions with regards to infants' differential attention to negative emotions (fear or sad) versus positive emotions (happy) for the bimodal, dynamic events used in this study. In the future, dynamic events should continue to be used, even alongside static events so that they may be compared. However, it is clear that the field should be turning more and more towards the use of the more ecologically-valid dynamic events. This is especially true given the increased use of eye-tracking technology in infancy research, which allows us to track precisely where infants are looking on the screen even when the faces are moving.

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Footnotes

[1] Kurtosis and skewness estimates indicated substantial positive bias in the latency scores for several of the experimental events (i.e., skewness values > 1.0); no substantial bias was seen in the fixation duration or fixation count measures. Thus, these same ANOVA models were conducted again on log-transformed latency measures, but the pattern of results did not change from that which is reported on the unadjusted latency values.

Table 1

Descriptive Statistics

	Condition	Dynamic			Static		
Measure	Emotion	Happy	Sad	Fear	Happy	Sad	Fear
Fixation Duration	Face	10.45 s (6.62)	10.52 s (6.67)	7.60 s (5.23)	5.72 s (3.33)	6.61 s (3.52)	5.60 s (3.30)
	Mouth	6.52 s (5.37)	6.71 s (6.26)	5.16 s (4.95)	3.42 s (2.98)	3.13 s (2.68)	2.74 s (2.08)
	Eyes	4.77 s (3.68)	4.83 s (4.47)	3.47 s (3.67)	2.52 s (1.64)	4.19 s (2.69)	3.25 s (2.13)
Fixation Count	Face	19.65 (10.40)	17.82 (13.39)	12.06 (6.29)	13.53 (8.78)	16.35 (7.62)	13.76 (9.46)
	Mouth	10.65 (6.83)	9.00 (8.37)	6.59 (4.37)	6.35 (5.53)	6.53 (5.17)	5.71 (4.73)
	Eyes	9.00 (7.12)	9.12 (8.97)	5.76 (4.83)	7.12 (7.27)	9.76 (5.78)	8.06 (6.75)
Latency	Distractor	3429.65 s (4748.80)	4362.06 s (5838.56)	5222.35 s 6379.97	5060.59 s (5319.07)	3367.65 s (4243.54)	3889.47 s (4419.85)
Latency	Low Loco (n=8)	1940.38 s (1670.55)	4867.25 s (6090.29)	2472.25 s (4907.51)	5001.50 s (5054.87)	4007.63 s (3635.00)	3002.25 s (2290.91)
	High Loco (n=9)	4753.44 s (6202.50)	3913.00 s (5936.36)	7666.89 s (6785.95)	5113.11 s (5849.84)	2798.78 s (4866.21)	4678.11 s (5729.94)
Latency	Lower Parent Neg Affect (n = 11)	2049.45 s (2555.21)	3667.82 s (5365.38)	8573.00 s (6909.39)	5527.73 s (5496.99)	3293.00 s (3626.49)	4584.82 s (5264.53)
	Higher Parent Neg Affect (n = 6)	5960.00 s (6872.51)	5634.83 s (6964.57)	8573.00 s (6909.39)	4204.17 s (5361.15)	3504.50 s (5593.45)	2614.67 s (1952.86)

Table 2

Summary of Statistical Results

		F	*p*-value	Effect Size	Power
Fixation Duration (s)					
	Emotion x Condition (Face Only)				
	Emotion	2.74	0.08	0.15	0.50
	Condition	17.82	0.01*	0.53	0.98
	Emotion x Condition	1.45	0.25	0.08	0.29
	Emotion x Condition x AOI				
	Emotion	1.80	0.18	0.10	0.35
	Condition	11.86	0.01*	0.43	0.90
	AOI	0.71	0.41	0.04	0.13
	Emotion x Condition	0.84	0.44	0.05	0.18
	Emotion x AOI	0.82	0.45	0.05	0.18
	Condition x AOI	5.16	0.04*	0.24	0.57
	Emotion x Condition x AOI	1.07	0.35	0.06	0.22
Fixation Count					
	Emotion x Condition (Face Only)				
	Emotion	3.66	0.04*	0.19	0.63
	Condition	3.17	0.09	0.17	0.39
	Emotion x Condition	1.99	0.15	0.11	0.38
	Emotion x Condition x AOI				
	Emotion	3.42	0.05*	0.18	0.60
	Condition	3.31	0.09	0.17	0.40
	AOI	0.16	0.69	0.01	0.07
	Emotion x Condition	1.94	0.16	0.11	0.37
	Emotion x AOI	1.24	0.30	0.07	0.25
	Condition x AOI	5.12	0.04*	0.24	0.57
	Emotion x Condition x AOI	0.07	0.93	0.004	0.06
Latency (ms)					
	Emotion	0.16	0.85	0.01	0.07
	Condition	0.06	0.81	0.004	0.06
	Emotion x Condition	1.06	0.36	0.06	0.22
	Between-Subjects: Locomotion				
	Main Effects				

Emotion	0.11	0.90	0.01	0.07
Condition	0.03	0.86	0.002	0.05
MedLoco	0.89	0.36	0.06	0.14
Interactions				
Emotion x Condition	1.02	0.37	0.06	0.21
Emotion x MedLoco	1.79	0.19	0.11	0.34
Condition x MedLoco	1.26	0.28	0.08	0.18
Emotion x Condition x MedLoco	0.28	0.76	0.02	0.09
Between-Subjects: Parent Negative Affect				
Main Effects				
Emotion	0.17	0.85	0.01	0.07
Condition	1.18	0.30	0.07	0.17
MeanNeg	0.88	0.36	0.06	0.14
Interactions				
Emotion x Condition	0.98	0.39	0.06	0.20
Emotion x MeanNeg	0.02	0.98	0.001	0.05
Condition x MeanNeg	7.64	0.01*	0.34	0.73
Emotion x Condition x MeanNeg	0.67	0.52	0.04	0.15

Note: *p significant at α=.05

Table 3

Correlations Among Study Variables

	1	2	3	4
1. Age at time of test	-			
2. Locomotion Raw Score	0.31	-		
3. Parental Negative Affect	0.11	0.23	-	
4. Parental Positive Affect	-0.00	-0.37	-0.43	-

Table 4

Correlations Between Study Variables and Latency to Look at the Distractor

	Happy Dynamic	Happy Static	Sad Dynamic	Sad Static	Fear Dynamic	Fear Static
1. Age at time of test	-0.39	-0.32	-0.11	-0.55*	-0.11	-0.50*
2. Locomotion Raw Score	0.17	-0.21	-0.01	-0.35	0.32	-0.03
3. Parental Negative Affect	0.10	-0.26	0.12	-0.04	0.33	-0.42
4. Parental Positive Affect	-0.32	0.32	0.37	-0.06	-0.09	-0.09

Note * $p < .05$

Table 5A

Correlations Between Study Variables and Fixation Duration to the Face AOI

	Happy Dynamic	Happy Static	Sad Dynamic	Sad Static	Fear Dynamic	Fear Static
1. Age at time of test	0.18	0.37	0.46	0.55*	0.46	0.38
2. Locomotion Raw Score	-0.15	0.05	0.06	0.19	0.02	0.08
3. Parental Negative Affect	-0.21	-0.20	0.04	0.03	0.44	0.04
4. Parental Positive Affect	0.05	0.23	-0.10	-0.20	0.03	0.03

Note * $p < .05$

Table 5B

Correlations Between Study Variables and Fixation Count to the Face AOI

	Happy Dynamic	Happy Static	Sad Dynamic	Sad Static	Fear Dynamic	Fear Static
1. Age at time of test	-0.02	0.02	0.35	0.39	0.48*	0.24
2. Locomotion Raw Score	-0.18	-0.38	0.05	0.11	0.06	-0.09
3. Parental Negative Affect	-0.20	-0.12	0.14	-0.12	-0.02	0.07
4. Parental Positive Affect	0.01	0.22	-0.27	-0.14	-0.13	-0.03

Note * $p = .05$

Table 6A

Correlations Between Study Variables and Fixation Duration to the Mouth AOI

	Happy Dynamic	Happy Static	Sad Dynamic	Sad Static	Fear Dynamic	Fear Static
1. Age at time of test	0.29	0.43	0.46	0.61**	0.44	0.52*
2. Locomotion Raw Score	-0.08	-0.14	0.04	0.23	-0.10	0.23
3. Parental Negative Affect	-0.24	-0.22	-0.09	-0.06	0.10	-0.02
4. Parental Positive Affect	0.10	0.41	0.10	-0.00	0.08	0.12

Note * $p < .05$, ** p<.01

Table 6B

Correlations Between Study Variables and Fixation Count to the Mouth AOI

	Happy Dynamic	Happy Static	Sad Dynamic	Sad Static	Fear Dynamic	Fear Static
1. Age at time of test	0.15	0.43	0.46	0.66**	0.43	0.58*
2. Locomotion Raw Score	-0.01	0.01	0.02	0.41	-0.01	0.12
3. Parental Negative Affect	-0.10	0.02	0.14	0.08	-0.05	0.11
4. Parental Positive Affect	0.09	0.32	-0.08	-0.21	-0.06	0.17

Note * $p < .05$, ** p<.01

Table 7A

Correlations Between Study Variables and Fixation Duration to the Eyes AOI

	Happy Dynamic	Happy Static	Sad Dynamic	Sad Static	Fear Dynamic	Fear Static
1. Age at time of test	-0.07	-0.17	0.10	0.05	0.06	0.07
2. Locomotion Raw Score	-0.14	-0.25	0.24	-0.01	0.05	-0.06
3. Parental Negative Affect	-0.05	-0.15	0.03	0.08	0.10	0.05
4. Parental Positive Affect	0.12	-0.09	-0.35	-0.12	0.16	-0.17

Table 7B

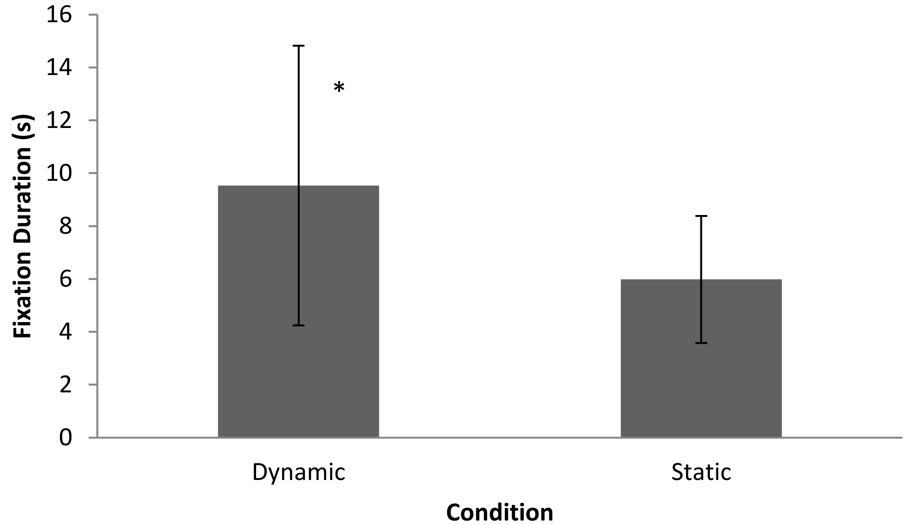
Correlations Between Study Variables and Fixation Count to the Eyes AOI

	Happy Dynamic	Happy Static	Sad Dynamic	Sad Static	Fear Dynamic	Fear Static
1. Age at time of test	-0.19	-0.33	0.10	-0.05	0.26	-0.07
2. Locomotion Raw Score	-0.27	-0.50*	0.03	-0.23	0.13	-0.21
3. Parental Negative Affect	-0.20	-0.17	0.10	-0.22	0.00	0.02
4. Parental Positive Affect	-0.07	0.04	-0.31	0.01	-0.16	-0.17

Note * $p < .05$

Figure 1A

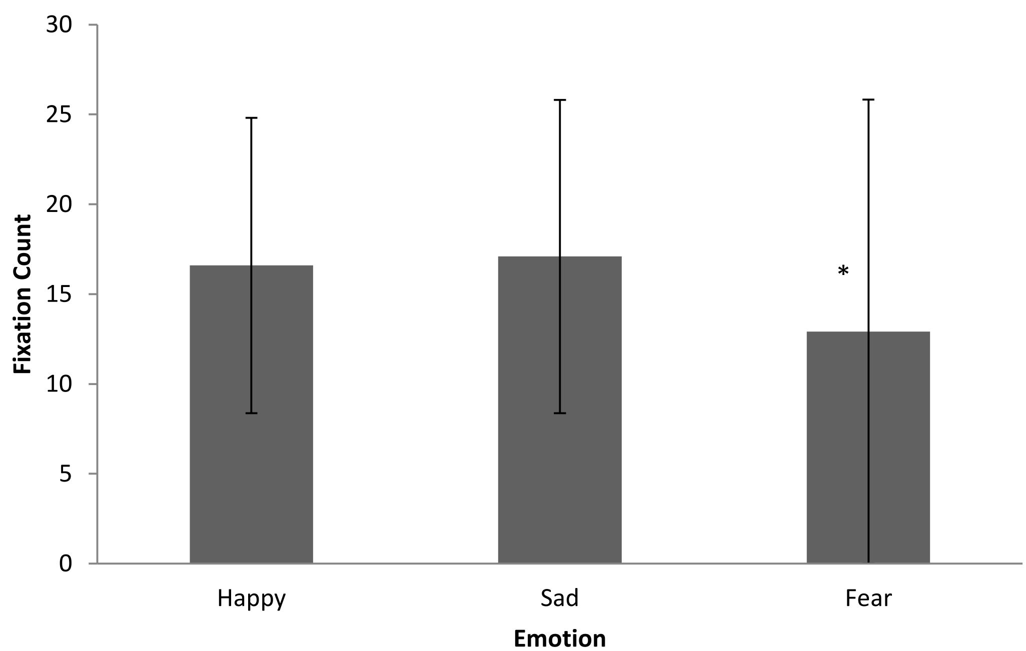
Gaze Duration on the Face: Main Effect of Condition (Dynamic v. Static)



**p*=.001

Figure 1B

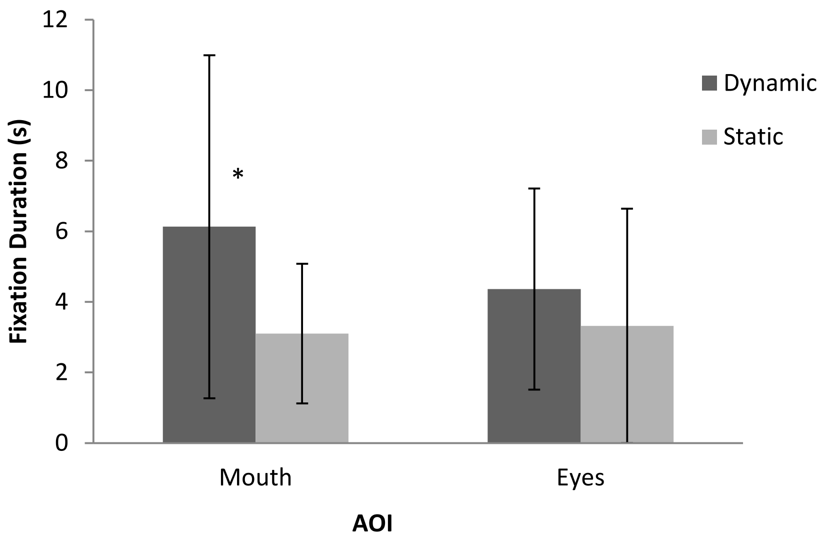
Gaze Frequency on the Face: Main Effect of Emotion (Happy v. Sad v. Fear)



**p*=.001

Figure 2A

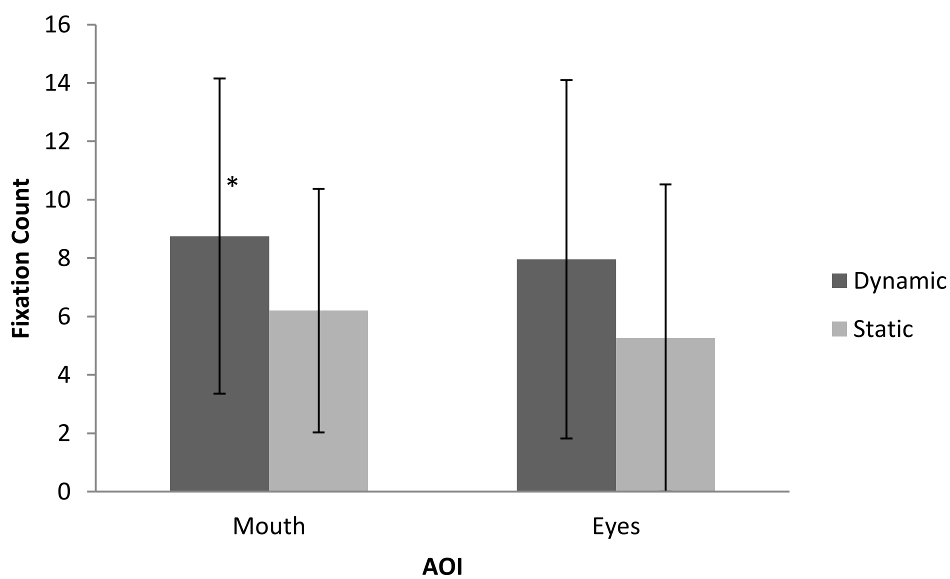
Fixation Duration: Condition (Dynamic, Static) x AOI (Mouth, Eyes)



* $p < .01$

Figure 2B

Fixation Count: Condition (Dynamic, Static) x AOI (Mouth, Eyes)



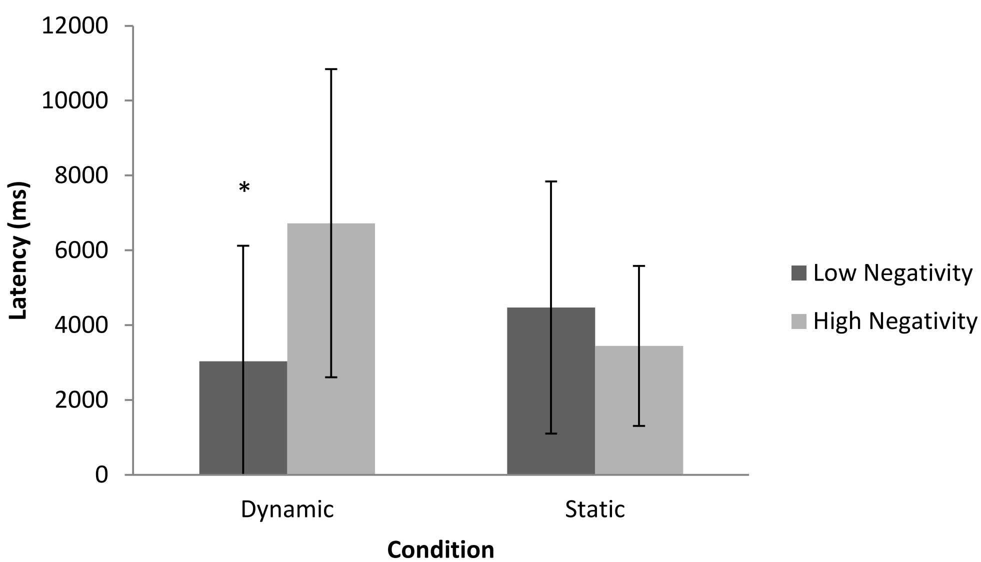
*$p < .01$

Figure 3A

Average Latency to Look at the Distractor: Emotion x Condition

Figure 3B

Average Latency to Look at the Distractor: Condition x Negative Parent Affect



*p=.05

Appendix A

Demographics questionnaire

Infant #_________ Experiment #__________

Infant Perception Laboratory

Family Information Sheet

(All information is strictly confidential)

Infant's Birthdate: ______________ Mother's Age:___________ Father's Age:____________

Mother's Occupation: __________________ Father's Occupation:________________ _______

Mother's Education: High School Partial College College Master's Ph.D.

Father's Education: High School Partial College College Master's Ph.D.

Annual Family Income: $10,000-$20,000 $20,000-$35,000 $35,000-$50,000 $50,000-$65,000 $65,000-$80,000 $80,000-$95,000 > $95,000

Marital Status: Married Separated Divorced Unmarried/Single Widowed

Mother's Race: White/Caucasian African American Hispanic Asian Native American

Other____________________

Father's Race: White/Caucasian African American Hispanic Asian Native American

Other____________________

Was your infant: Full Term (38-42 weeks) Premature (≤ 37 weeks) Postmature (>42 weeks)

Infant's Birthweight: ____________ lbs _____________ozs

Has your infant had any medical problems? Yes No Please List:______________________

Please list the birth date and gender of any older children:

________________________________ M F________________________________ M F

________________________________ M F ________________________________ M F

What is the primary language spoken in your home?__________________________________

Please list any other languages that are spoken in your home: ____________________________

Does your infant watch any T.V.? Yes No Please list:____________________________

Has any child in the family been suspected of a developmental delay/diagnosis? Yes No

If yes, please describe: ____

How did you find out about our study? Letter Brochure Friend Lecture

Appendix B

Phrases Used in Events

Happy:

We laughed and clapped and danced until the sun left the sky, and the moon rose above. It was beautiful night, full of magic! The air smelled like cookies baking in the oven, and all of our tummies were pleased. Smiles were on every face! Everything was perfect. It was the best night of my life. (56 words)

Sad:

It broke my heart to lose the bell. When the train reached my house, I sadly left the other children. I stood at my doorway and waved good-bye. The conductor said something from the moving train, but I couldn’t hear him. The train let out a long, lonely whistle and faded into the night. (54 words)

Fear:

The horrible animal rushed toward me, foaming at the mouth. The wolf ducked down, and then it leaped up, snapping its huge jaws at me. I gasped and twisted around, but it was on me, trying to pull me out. Even if the wolf was fake, it was the creepiest thing I had ever seen. (55 words)

Appendix C

Informed Consent for Actresses

Informed Consent for Emotion Videos

I give my consent to Dr. Robin Panneton, Alison Heck and her research assistants to video tape me as I read short utterances while expressing the following emotional states: happy, sad, and fear. Dr. Panneton has my permission to use these video segments during testing of typical and non-typical infants and children (e.g., children with an autism spectrum diagnosis) for their ability to recognize emotion expressions in adult females. They may also use one or more of my segments as demonstration of the procedure during scientific presentations (e.g., a research talk at a conference).

Signed:____

Printed Name:____

Date: ____

Appendix D

Emotion Rating Questionnaire

EMOTION IDENTIFICATION/INTENSITY SCALE

Your gender: M F Your age:__________

Please circle the category of the emotion being portrayed, and then circle the value that best represents the emotional intensity.

Video 1:
-Emotion Category: Happy Sad Fear Neither
-Emotion Intensity:
-4 -3 -2 -1 0 +1 +2 +3 +4
(very negative) (neutral) (very positive)

Video 2:
-Emotion Category: Happy Sad Fear Neither
-Emotion Intensity:
-4 -3 -2 -1 0 +1 +2 +3 +4
(very negative) (neutral) (very positive)

Video 3:
-Emotion Category: Happy Sad Fear Neither
-Emotion Intensity:
-4 -3 -2 -1 0 +1 +2 +3 +4
(very negative) (neutral) (very positive)

Video 4:
-Emotion Category: Happy Sad Fear Neither
-Emotion Intensity:
-4 -3 -2 -1 0 +1 +2 +3 +4
(very negative) (neutral) (very positive)

Video 5:
-Emotion Category: Happy Sad Fear Neither
-Emotion Intensity:
-4 -3 -2 -1 0 +1 +2 +3 +4
(very negative) (neutral) (very positive)

Video 6:
-Emotion Category: Happy Sad Fear Neither
-Emotion Intensity:
-4 -3 -2 -1 0 +1 +2 +3 +4
(very negative) (neutral) (very positive)

Video 7:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 8:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 9:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 10:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 11:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 12:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 13:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 14:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 15:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 16:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 17:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 18:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 19:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 20:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 21:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4 -3 -2 -1 0 +1 +2 +3 +4

(very negative) (neutral) (very positive)

Video 22:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4	-3	-2	-1	0	+1	+2	+3	+4
(very negative)				(neutral)				(very positive)

Video 23:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4	-3	-2	-1	0	+1	+2	+3	+4
(very negative)				(neutral)				(very positive)

Video 24:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4	-3	-2	-1	0	+1	+2	+3	+4
(very negative)				(neutral)				(very positive)

Video 25:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4	-3	-2	-1	0	+1	+2	+3	+4
(very negative)				(neutral)				(very positive)

Video 26:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4	-3	-2	-1	0	+1	+2	+3	+4
(very negative)				(neutral)				(very positive)

Video 27:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4	-3	-2	-1	0	+1	+2	+3	+4
(very negative)				(neutral)				(very positive)

Video 28:

-Emotion Category: Happy Sad Fear Neither

-Emotion Intensity:

-4	-3	-2	-1	0	+1	+2	+3	+4
(very negative)				(neutral)				(very positive)

Appendix E

Informed Consent

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants in Research Projects Involving Human Subject

Title:
Infants' Scanning of Faces

Principle Investigators:
Dr. Robin Panneton
Alison Heck

I. Purpose of this Research/Project
The purpose of this project is to investigate infants' attention to faces. We will show your infant a variety of movie clips of women who are either talking or looking at objects. We are interested in how infants look at these faces depending on properties of the voices (for example, whether the voice is synchronized to the movements of the mouth).

II. Procedures
Your infant will be tested for approximately 15 minutes. The baby will be placed in a light-weight car seat, and then positioned on the lap of either you or a research assistant. This is to keep the infant in close touch with an adult, but somewhat restricted in his/her ability to freely move about. The infant will face a monitor of an eye-tracking system. All movies will be presented on this screen. First, the infant will see a simple screen with moving dots so that we can calibrate their eye positions. Then the infant will see a series of movie clips of women speaking or looking at objects, interspersed with 10 sec clips of Sesame Street scenes. The location and duration of each eye movement that your infant produces during this entire sequence is recorded by the eye tracker. If for any reason, your infant cries or falls asleep, testing will be discontinued.

III. Risks
There are no apparent risks to your infant or to yourself for participation in this study. Sound levels for all auditory stimuli will be verified prior to the testing of each infant.

IV. Benefits
Although there are no direct benefits to the participants in this study, all parents will receive a summary report of the results of this project (a general analysis of the patterns of looking across all of the infants). Parents will also receive a certificate of appreciation and the results of the study will contribute to a broader body of research on infant social attention and language learning.

V. Extent of Anonymity and Confidentiality
All of the information gathered in this study will be kept confidential and the results will not be released without parental consent. However, the results of this project may be used for scientific and/or educational purposes, presented at scientific meetings, and/or published in a scientific journal.

VI. Compensation
There is no compensation to be earned from participation in this project.

VII. Freedom to Withdraw
You have the right to terminate your infant's involvement at any point in time and for any reason should you chose to do so.

VIII. Participant's Responsibilities
I voluntarily agree to have my infant participate in this study.

IX. Participant's Permission
I have been given an opportunity to ask further questions about this procedure and I understand that I have the right to end this session for any reason if I so choose. This project has been approved by the Human Subjects Committee of the Department of Psychology and the Institutional Review Board of Virginia Tech. If I have any questions regarding this research and its conduct, I should contact one of the persons named below. Given these procedures and conditions, I give my permission to Dr. Panneton, Ms. Heck and their co-workers to test my son/daughter.

Dr. Robin Panneton, Principle Investigator	231-5938
Alison Heck, Graduate Student and Co-Investigator	231-3972
Dr. David Harrison, Chair, Human Subjects Committee	231-4422
David M. Moore, DVM, Assistant Vice Provost for Research Compliance	231-4991

Signature of Parent: ____

Date: ____

Infant's Name: ____

I would like to be contacted by phone regarding future studies: YES NO

Appendix F

Locomotion measure

Vineland-II Gross Motor subscale

Sparrow, S.S., Balla, D.A., & Cicchetti, D. (2005). Vineland Adaptive Behavior Scales (Vineland-II). Pearson Assessments, Bloomington, MN.

Appendix G

PANAS-X Measure

PANAS-X-Modified

Read each item and then mark the appropriate answer in the space next to the word. Indicate to what extent you generally feel this way, that is, how you feel on average.

Use the following scale to record your answers:

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

______ interested
______ nervous
______ proud
______ active
______ upset
______ jittery
______ attentive
______distressed
______ strong
______ hostile
______ frightened
______ cheerful
______ inspired
______ alone
______ guilty
______ energetic
______ joyful
______ sad
______ excited
______ afraid
______ delighted
______ lonely
______ ashamed
______ enthusiastic
______ concentrating
______ blue
______ irritable
______ happy
______ shaky
______ alert
______ downhearted
______ lively
______ scared
______ determined

General Dimension Scales

Negative Affect (10):	afraid, scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, distressed
Positive Affect (10):	active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, strong

Basic Negative Emotion Scales

Fear (6):	afraid, scared, frightened, nervous, jittery, shaky
Sadness (5):	sad, blue, downhearted, alone, lonely

Basic Positive Emotion Scales

Joviality (8):	happy, joyful, delighted, cheerful, excited, enthusiastic, lively, energetic
Attentiveness (4):	alert, attentive, concentrating, determined

Watson, D. & Clark, L.A. (1999). The PANAS-X: Manual for the Positive and Negative Affect Schedule-expanded form. Iowa: The University of Iowa. http://ir.uiowa.edu/psychology_pubs/11/.