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INFANTS' PERCEPTION OF EMOTION FROM DYNAMIC BODY MOVEMENTS

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INFANTS' PERCEPTION OF EMOTION FROM DYNAMIC BODY
MOVEMENTS

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Arts and Science at the University of Kentucky

By
Nicole R. Zieber

Lexington, Kentucky

Director: Dr. Ramesh S. Bhatt, Professor of Psychology

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2012

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ABSTRACT OF DISSERTATION

INFANTS' PERCEPTION OF EMOTION FROM DYNAMIC BODY MOVEMENTS

In humans, the capacity to extract meaning from another person's behavior is fundamental to social competency. Adults recognize emotions conveyed by body movements with comparable accuracy to when they are portrayed in facial expressions. While infancy research has examined the development of facial and vocal emotion processing extensively, no prior study has explored infants' perception of emotion from body movements. The current studies examined the development of emotion processing from body gestures. In Experiment 1, I asked whether 6.5-month-olds infants would prefer to view emotional versus neutral body movements. The results indicate that infants prefer to view a happy versus a neutral body action when the videos are presented upright, but fail to exhibit a preference when the videos are inverted. This suggests that the preference for the emotional body movement was not driven by low-level features (such as the amount or size of the movement displayed), but rather by the affective content displayed.

Experiments 2A and 2B sought to extend the findings of Experiment 1 by asking whether infants are able to match affective body expressions to their corresponding vocal emotional expressions. In both experiments, infants were tested using an intermodal preference technique: Infants were exposed to a happy and an angry body expression presented side by side while hearing either a happy or angry vocalization. An inverted condition was included to investigate whether matching was based solely upon some feature redundantly specified across modalities (e.g., tempo). In Experiment 2A, 6.5-month-old infants looked longer at the emotionally congruent videos when they were presented upright, but did not display a preference when the same videos were inverted. In Experiment 2B, 3.5-month-olds tested in the same manner exhibited a preference for the incongruent video in the upright condition, but did not show a preference when the stimuli were inverted. These results demonstrate that even young infants are sensitive to emotions conveyed by bodies, indicating that sophisticated emotion processing capabilities are present early in life.

KEYWORDS: Infancy, Emotion Perception, Body Processing, Face Perception, Intermodal Preference

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DEDICATION

This paper is dedicated to my grandfather, Roger Giles. He has supported me in all my endeavors and always believed in me, but most of all, he was quick to let me know how much he loved me. He always made me feel like I was the most special person in the world. I miss you so much Papa.

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TABLE OF CONTENTS

Acknowledgments.....	iii
List of Tables.....	v
List of Figures.....	vi
Chapter 1: The Significance of Emotion Perception	1
Chapter 2: Predictions Based Upon Current Theory	5
Chapter 3: Infants' Perception of Facial and Vocal Expressions of Emotion.....	8
Chapter 4: Parallels Between Faces and Bodies	11
Chapter 5: Overview of Current Studies	15
Chapter 6: Experiment 1	16
Method	16
Participants	16
Stimuli	16
Apparatus and Procedure	17
Results and Discussion	18
Chapter 7: Intermodal Perception of Emotion	22
Chapter 8: Experiment 2A	24
Method	24
Participants	24
Stimuli	24
Apparatus and Procedure	25
Results and Discussion	25
Chapter 9: Experiment 2B.....	29
Method.....	29
Participants.....	29
Stimuli, Apparatus and Procedure.....	29
Results and Discussion	29
Chapter 10: General Discussion.....	34
Infants' Preference for Emotional Body Movement	34
Infants Utilize Affective Information to Discriminate Emotional Body Movements	35
Intermodal Matching	36
Young Infants' Discrimination of Affective Information.....	38
Implications for Future Research	41
Concluding Remarks	43
References	46
Vita.....	59

LIST OF
TABLES

Table 6.1, Experiment 1	20
Table 8.1, Experiment 2A	27
Table 9.1, Experiment 2B	32

LIST OF FIGURES

Figure 6.1.....	21
Figure 8.1.....	28
Figure 9.1.....	33
Figure 10.1.....	45

Chapter 1: The Significance of Emotion Perception

The capacity to understand another individual's feelings is necessary for establishing and maintaining social relationships. Consequently, a wealth of research has examined how adults process emotions in faces, voices, and to a lesser extent, from body postures or movement. Bodies are a significant source of emotion information, and under some circumstances (such as when a person is at a distance or when action is required), body movements may be more important sources of emotion information than faces (de Gelder, 2009). Adults are adept at processing emotion in both bodies and faces (Atkinson, Dittrich, Gemmell, & Young, 2004; Coulson, 2004). Nevertheless, a significant gap exists in our understanding of the development of emotion perception: While infants' perception of emotion from facial and vocal expressions has been studied extensively, no research has explored infants' sensitivity to emotion portrayed in bodies. The current research takes an important first step by demonstrating that young infants perceive emotion in body movements and match them to emotional vocalizations.

Social interaction relies on the ability to accurately interpret communicative signals. Typically, by the time individuals reach adulthood, they have become adept at perceiving emotion from a variety of different cues, such as facial and vocal expressions, as well as body postures and movements. The importance of accurate emotion processing becomes most apparent when one considers populations that display deficient or maladaptive emotion perception, such as individuals with autism or other pervasive developmental disorders. These disorders are characterized by a lack of attention to social stimuli as well as an inability to interpret and respond to social signals in others, which interferes with the development of successful interpersonal relationships and social

functioning. Because attaining a level of expertise at processing emotion is such a vital part of development, a great deal of research has examined exactly how we perceive emotions as well as when and how this ability develops.

From an evolutionary standpoint, it is quite easy to understand why accurate and rapid recognition of another's emotional state would be considered to be a useful adaptation. Whether detecting a threat in one's environment or predicting a conspecific's behavior based upon their affective state, the processing of emotion is important to an organism's survival. Therefore, it is not surprising that humans rapidly perceive emotion (in as little as 120-180 ms) in facial expressions (Eimer & Holmes, 2008; Prkachin, 2003; Stanners, Byrd, & Gabriel, 1985) even when they are not aware they are doing so (Dimberg, Thunberg, & Elmehed, 2000; Kiss & Eimer, 2008). Adults quickly detect an emotional face in a crowd (Becker, Anderson, Mortensen, Neufeld, & Neel, 2011; Hansen & Hansen, 1988; Pinkham, Griffin, Baron, Sasson, & Gur, 2010), and their responsiveness to angry or threat-related facial expressions is faster than that to other emotional faces (Hansen & Hansen, 1988; Holmes, Green, & Vuilleumier, 2005). Izard (2009) has proposed that basic emotions aid in the organization and motivation of rapid behavior in response to challenges in the environment, and research has found when viewing another's facial expression, adults' own emotional response is triggered very quickly (120 ms) (Eimer & Holmes, 2007; Tamietto et al., 2009; Vuilleumier & Pourtois, 2007). Further support for the evolutionary conservation of certain emotional expressions comes from studies indicating that some basic emotions (i.e., happiness, sadness, anger, fear, disgust, surprise) are accurately recognized across diverse cultures (Ekman, 1972; Ekman & Friesen, 1971; Ekman, Sorenson, & Friesen, 1969; Ekman et al., 1987;

Elfenbein & Ambady, 2003).

While a great deal of emotion research has focused on facial expressions, a smaller amount of research has examined the perception of emotion from auditory stimuli. These studies have found that adults also correctly identify emotions presented in verbal prosody (Banse & Scherer, 1996), nonverbal utterances (Sauter, Eisner, Calder, & Scott, 2010), and even in music (Balkwill & Thompson, 1999). Additionally, cross-cultural studies have found accurate emotion recognition of basic emotions from Western and non-Western societies for spoken sentences (Bryant & Barrett, 2008), nonverbal vocalizations (Sauter, Eisner, Ekman, & Scott, 2010), and evocative music (Balkwill, Thompson, & Matsunaga, 2004; Fritz et al., 2009). The fact that basic emotions are recognized across a variety of modalities (facial, vocal) and cultures supports the notion that accurate recognition of another's affective state may have evolved as an important survival tool.

As previously mentioned, the amount of research on perception of vocal emotional expressions is relatively modest compared to research on facial expressions; however, even less research has examined emotion processing from bodies. Adults demonstrate a high level of expertise in extracting socially relevant information from bodies (Atkinson et al., 2004; Coulson, 2004; de Gelder, 2009). When viewing bodies, adults obtain information about gender, identity, affective state, and intentions (Walk & Homan, 1984; Walk & Walters, 1988; Walters & Walk, 1986). Studies indicate that adults' accuracy in identifying emotions conveyed in body postures and movements is comparable to their accuracy in perceiving emotions from faces (Atkinson, et al., 2004; Atkinson, Tunstall, & Dittrich, 2007; Coulson, 2004). These studies established that

adults can both identify and judge the intensity of emotions from dynamic and static body postures when facial cues are unavailable, even if the body information is limited to point-light displays (Atkinson et al., 2004; Atkinson, et al., 2007). Additionally, adults demonstrate rapid emotional responses (120 ms) when viewing emotional body postures (van Heijnsbergen, Meeren, Grezes, de Gelder, 2007; Tamietto et al., 2009), and are quick to detect emotion from bodies in a crowd (McHugh, McDonnell, O'Sullivan, & Newell, 2009). Under certain circumstances, such as when one sees someone at a distance, body information may even be utilized before face information (de Gelder, 2009). Thus, the study of adults' processing of emotional body expressions has become an increasingly important area of research, but additional work with infant subjects is needed in order to understand the developmental mechanisms behind such abilities.

Because emotion perception is so vital to an individual's survival, the ability to perceive emotion information from a variety of modalities presumably develops early in life. Yet to date, no research has examined emotion processing from bodies in infancy, which is surprising given that infants' ability to perceive emotion from faces and voices is available in the first year of life. Additionally, most theories of emotion focus upon the recognition of facial expressions of emotion, and rarely address the development of emotion perception from bodies or other sources. However, while there may not be any one theory that makes predictions regarding infants' processing of emotional bodies, a review of theories related to emotion and action perception suggests that infants may perceive emotion in bodies as well.

Chapter 2: Predictions Based Upon Current Theory

Under the framework of differential emotions theory (DET), Izard proposes that basic emotion feelings (e.g., fear, happiness) serve to organize and motivate rapid responses to relevant persons or events in the individual's environment (Izard, 2009). A main tenet of DET posits that emotions are universally similar in how they are experienced and classified (at least for a small set of basic emotions); therefore, these basic emotions are discrete (with each consisting of unique organization and expression) and inherently adaptive (Izard, 1977; Izard, 2007a; Izard, 2007b; Izard, 2008; Izard, 2009). This has been validated by several cross-cultural studies of emotion that have found accurate identification for basic emotions (happiness, sadness, fear, anger, disgust, and surprise) (Bryant & Barrett, 2008; Ekman et al., 1969; Ekman & Friesen, 1971; Sauter et al., 2010). Additionally, recent research has found that basic emotions are identified with comparable accuracy when viewed in bodies as they are in faces (Atkinson et al., 2004; Atkinson et al., 2007; Coulson, 2004). Because of the universal nature and intrinsic significance of basic emotions to the individual, DET also suggests that the production and perception of some basic emotions is possible early in life (Izard, Woodburn, & Finlon, 2010), and numerous studies on infants' processing of emotional faces have supported this conclusion (Barrera & Maurer, 1981; Field et al., 1983; Field, Woodson, Greenberg, & Cohen, 1982; Fernald, 1993; Kuchuk, Vibbert, & Bornstein, 1986; Montague & Walker-Andrews, 2001; Schwartz, Izard, & Ansel, 1985). While the perception of emotion from bodies has not been examined in infancy, it seems likely that the same principle will be true for bodies as it is for faces. That is, if certain basic emotions are characterized by specific, invariant properties that can be recognized across

different cultures and modalities, one would expect comparable recognition of these emotions when portrayed in body expressions as when they are conveyed in facial and vocal expressions.

When considering infants' perception of affective body actions, one should also consider the large amount of research that has examined infants' perception of intentional actions (generally referred to as "action perception"). In this line of research, it has been proposed that infants' understanding of a person's goal-directed actions develops sometime between 5-12 months of age (Buresh & Woodward, 2007; Woodward, 2009). Additionally, 12-month-olds connect information about a person's affect to their perception of the actions that they perform on an object (Phillips, Wellman, & Spelke, 2002). While the current study investigated the ability to perceive affective body actions at a younger age, it seems likely that before infants associate a person's affect with an object they are utilizing, they must first recognize the affect conveyed within the person's own body actions.

Action perception research has also found that infants are also more likely to discriminate the goal of an action once the infant has produced the action themselves (Hauf, 2009; Sommerville & Woodward, 2005), suggesting a link between action production and action perception. It may be that infants' own production of emotional body movement aids in the discrimination of body movements characteristic of different affective states. While infants' emotional body movements are obviously different from those displayed by adults, they still share similar features that may allow infants to recognize the affect conveyed; for example, anger may be associated with rigidity of limbs, sharp movements, and a tense body whether viewed in an adult or an infant's

angry actions. This is consistent with Meltzoff's (2005) "Like me" hypothesis, which argues that infant imitation is constrained to others "like me" and eventually leads to the understanding of others' intentions and goals. Recent neuroscience research supports this hypothesis: the discovery of mirror neurons (which fire both when one is executing an action and when viewing another performing the same action) has led researchers to conclude that self-production of actions plays an integral part of learning about action perception (Del Giudice, Manera, & Keysers, 2009). Meltzoff (2005) proposes that infants project mental states associated with particular actions they have performed to other individuals seen performing similar acts, which may be applicable to emotional bodies as well. It may be that because young infants themselves produce angry and happy body movements, they recognize when an adult is conveying these emotions through body movements.

Thus, while no specific theory makes the direct prediction that infants perceive emotion portrayed by bodies, this prediction is concomitant with prominent theories such as DET and the "Like me" hypothesis. If infants discriminate emotions from body movements, then in the future, it will be necessary for various theories of the development of emotion perception to address emotion processing from channels other than just facial expressions.

Chapter 3: Infants' Perception of Facial and Vocal Expressions of Emotion

While current theories of emotion may only provide speculative insight as to infants' abilities to process emotion from bodies, it is clear from previous research that infants' social capabilities are rapidly developing in the first year of life. From birth, human infants' attention is directed toward social stimuli (such as faces, voices, and bodies) that provide the exposure necessary to facilitate social learning. Shortly after birth, neonates look longer at faces or face-like objects (Johnson, Dziurawiec, Ellis, & Morton, 1991) and display a preference for their own mother's face, even after only brief exposure (Bushnell, 2001). Newborns prefer their mother's voice (DeCasper & Fifer, 1980), will turn their gaze toward the direction of a sound (Muir & Field, 1979), and will look longer at faces when they are accompanied by a voice (Haith, Bergman, & Moore, 1977). Newborns prefer to view biological over non-biological motion (Simion, Regolin, & Bulf, 2008), which perhaps serves to direct infants' attention to conspecifics as potential partners for social interactions. In sum, these remarkable early behaviors ensure that infants rapidly gain experience with a variety of social stimuli.

During the first year, this experience with social stimuli helps to develop infants' capacity to understand intention and affective state displayed in others. Emotion research has identified six "basic emotions" which seem to be universally recognized across different cultures (Ekman, 1972), and most infant research examines emotion processing in respect to these emotions by using images of static facial expressions. In the study of infants' perception of emotion, distinctions have been made between "discrimination" and "recognition" of emotional expressions. Discrimination indicates that the infant perceives the difference between two emotions, while recognition implies that the infant

extracts meaning from the expression (Walker-Andrews, 1997). While infants may not fully understand the internal state or all situations that lead to a specific emotional expression, infants may realize that an emotional expression signifies a certain kind of interaction or is reliably paired with particular behaviors. There are some studies that suggest that even newborns may discriminate some basic facial expressions (Field et al., 1983; Field et al., 1982). However, it has been suggested that this type of discrimination is either due to a perceptual bias to attend to invariant configurations of features that signify an emotional expression (Lepannen & Nelson, 2006; Nelson, 1987) or is based on changes in salient features (toothy smile, closed mouth) rather than identification of affective information specifying emotion (Caron, Caron, & Myers, 1982; Nelson, 1987; Oster, 1981). Many studies suggest that by 3 to 4 months of age infants can discriminate happiness, sadness, anger, fear and surprise in images of static faces (Barrera & Maurer, 1981; LaBarbara, Izard, Vietze, & Parisi, 1976; Schwartz et al., 1985; Young-Browne, Rosenfeld, & Horowitz, 1978). However, most researchers agree it is not until sometime between 5 to 7 months of age that infants demonstrate evidence of *recognition* of emotional facial expressions (Ludemann, 1991; Ludemann & Nelson, 1988; Nelson & Dolgin, 1985; Nelson, Morse, & Leavitt, 1979). Evidence from studies utilizing event-related potentials (ERPs) also indicate that by 7 months of age, infants show differential processing of happy, fearful, neutral, and angry expressions (Hoehl & Striano, 2008; Lepanen, Moulson, Vogel-Farley, & Nelson, 2007; Grossmann, 2010; Grossmann, Striano, & Friederici, 2008).

While fewer studies have examined vocal expressions of emotion, many studies have found infants to prefer infant-directed (ID) speech as opposed to adult-directed

(AD) speech (Fernald, 1985). Additionally, this preference has been found to be dependent upon the amount of positive affect conveyed in typical ID speech, such that when affect is held constant, 6-month-old infants display no preference for ID versus AD speech, and infants actually prefer AD speech if it displays more positive affect than ID speech (Singh, Morgan, & Best, 2002). This suggests that infants are sensitive to positive affect conveyed in vocal displays. This is in agreement with several studies that have found infants discriminate between happy, sad, and angry vocal expressions by 5 months of age (though only when presented in the context of a face) (Walker-Andrews & Grolnick, 1983; Walker-Andrews & Lennon, 1991). As infants demonstrate sensitivity to emotions conveyed by both facial and vocal expressions by 5 to 7 months of age, it seems likely the same should be true for emotional body expressions.

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Chapter 4: Parallels Between Faces and Bodies

In the present study, it was predicted that 6.5-month-old infants would be sensitive to emotional body movements. This prediction follows from the fact that faces and bodies share numerous similarities in how they are experienced and processed, and at 5-7 months of age, infants are able to discriminate facial emotions and will “match” these to affective vocalizations (Montague & Walker-Andrews, 2002; Soken & Pick, 1992, 1999; Walker, 1982; Walker-Andrews, 1986). Faces and bodies are alike in that the amount of exposure to both is greater than for other types of objects and the significance of this exposure is greater due to the social information they convey. As a result, adults process both faces and bodies in a distinct manner from other objects, which has been demonstrated both in behavioral and neuroimaging studies.

The most obvious similarity between faces and bodies is their ubiquity in daily life; an individual’s cumulative experience with bodies is likely the same as that with faces. Research using eye-tracking technology has shown that when viewing images of humans and other mammals in natural settings, adults fixate on face and body regions (compared to scanning the entire area of a picture) (Kano & Tomonaga, 2010). Presumably, attention is directed to faces and bodies because they both are important sources of relevant social information. In one study by Planalp, DeFrancisco, & Rutherford (1996), participants were asked to report which cues (out of 10 categories - face, body, activity, physiological, voice, direct verbal, indirect verbal, context, trait, and other) they used to recognize the emotion conveyed by a familiar individual. The subjects reported on average using a total of 6-7 different cues; with over half of the 186 participants reporting they used facial cues, and nearly half reported using body cues.

While vocal emotion was reported most frequently (19% of all cues; 24% of “most important” cues), facial cues (13% of all cues; 18% of “most important” cues) and body cues (11% of all cues; 12% of “most important” cues) were close behind in their frequency. [Technically, the categories of “body” and “activity” (12% of all cues; 7% of “most important” cues) both represent body actions, so the amount of body cues reported could be considered even higher (Planalp, DeFrancisco, & Rutherford, 1996)].

Faces and bodies also share a number of abstract configural properties. Both have specified parts (e.g., eyes, nose; legs, arms) that are constrained to a prototypical relationship (eyes above nose, nose above mouth; head above torso, legs below torso, arms extending from torso), with the relative size of these parts providing detailed information for recognition and identification of specific bodies. Given these correspondences between bodies and faces, one would expect the representation and processing of both to share some similarities as well. In the emerging research with adults, parallels have been discovered in the manner which the perceptual system regards faces and bodies. Namely, both have a “special” status in how they are processed compared to other objects. Initially, faces were believed to benefit from unique processing compared to other objects, as evidenced by the use of configural processing (Diamond & Carey, 1986). This type of processing relies upon the utilization of relational information, which takes into account the arrangement of features (e.g., eyes are above the nose) as well as the specific distances between features (e.g., the specific metric distance between the eyes) (Carey, 1992; Diamond & Carey, 1986; Tanaka & Gauthier, 1997). Recent research has suggested that configural processing is not unique to faces, but to any object that an individual has had enough exposure to develop expertise (Carey,

1992; Diamond & Carey, 1986; Gauthier & Tarr, 1997; Tanaka & Gauthier, 1997). Additionally, research has found adults utilize configural information when processing bodies as well (Reed, Stone, Bozova, & Tanaka, 2003; Reed, Stone, & McGoldrick, 2006). The processing of configural information is disrupted by stimulus inversion, and the presence of an inversion effect is seen as evidence of “expert” processing. Inversion effects have been documented for faces (Yin, 1969) as well as for bodies (Reed et al., 2003) in behavioral studies as well as in studies using event-related potentials (ERPs) (Stekelenberg & de Gelder, 2004). Additionally, ERP studies have found differential processing of normal faces and bodies as compared to the reorganized versions of the same images (with features and limbs placed in novel locations) (Gliga & Dehaene-Lambertz, 2005).

Recently, another similarity between faces and bodies has been discovered. Studies utilizing functional magnetic resonance imaging (fMRI) have documented dedicated brain areas for the processing of both faces and bodies. With faces, it has been demonstrated that an area in the ventral temporal lobe, referred to as the fusiform face area (FFA), responds selectively to face stimuli compared to other types of objects (Kanwisher, McDermott, & Chun, 1997). Two similar areas have been found to selectively respond to images of whole bodies and body parts; the extrastriate body area (EBA), located bilaterally in the posterior inferior temporal sulcus/middle temporal gyrus, and the fusiform body area (FBA), an area adjacent to the FFA in the fusiform gyrus (Peelen & Downing, 2005, 2007). These studies provide additional support to the behavioral findings indicating that faces and bodies both benefit from specialized processing compared to other objects.

In addition to the comparable significance of and processing of faces and bodies, another parallel exists between the two, in that one's perception of both faces and bodies is integrated with the subjective experience of using a face/body, a quality which has been termed "embodiment" (Gallese & Goldman, 1998; Reed et al., 2006). Embodiment refers to the phenomenon of the movement of our face/body affecting our visual recognition of the corresponding face/body of another person, which leads to a superior ability to extract detailed information about the human face or body. In relation to bodies, this suggests our "representations are not purely visual, neither in the inputs that activate the representation nor in the information contained in the representations" (Reed et al., 2006, p. 253). Due to the unique experience with one's body, motion information as well as knowledge of biomechanical constraints is likely intertwined in our body representation.

As there are numerous similarities between faces and bodies, it seems likely that emotion conveyed through facial or body expressions may be processed in a comparable manner. While there is no research that has examined bodies as potential sources of affective information in infancy, there have been studies with adults that have demonstrated an equivalent ability to recognize body and facial expressions (Atkinson et al., 2004; Coulson, 2004). Because infants demonstrate sensitivity to emotion conveyed by faces or voices early in life, it seems likely that they would also be sensitive to emotion conveyed through body movements.

Chapter 5: Overview of Current Studies

In Experiment 1, I assessed whether infants prefer to view emotional (happy) as opposed to neutral body actions. The present study provided a starting point in the investigation of infants' discrimination of emotion from bodies; thus, the happy and neutral stimuli were chosen for several reasons. Young infants prefer to view happy faces over neutral and other emotional faces, presumably due to extensive experience with this affect (Kuchuk et al., 1986; LaBarbara, et al., 1976; Kahana-Kalman & Andrews, 2001; Young-Browne et al., 1978). Also, in light of the fact that they are able to categorize facial expressions of happiness across several exemplars by 5 months of age (Bornstein & Arterberry, 2003), it was expected that infants will be sensitive to happy body movements from a young age as well. I first sought to determine whether infants discriminate any emotion from body movements, so testing with happy versus neutral body actions seemed a natural place to start. It was predicted that if infants perceived the affective information portrayed by the body movements, they would prefer to view happy body actions compared to neutral body actions.

Experiments 2A and 2B built upon Experiment 1 to examine whether infants discriminate between two emotions, happy and angry (as against emotional versus neutral movements in Experiment 1), and to test whether infants match emotional body movements to corresponding vocalizations. Discriminating between different emotional body actions would indicate that infants' knowledge about emotions from bodies extends to different individual classes of emotions. Moreover, matching emotional vocalization to appropriate body movements would suggest that infants derive at least some level of affective information from body movements (Walker-Andrews, 1997).

Chapter 6: Experiment 1

Experiment 1 utilized a paired-comparison looking procedure in which infants were tested with two video clips presented side by side (see Figure 7.1). One video depicted happiness while the other showed an affectively neutral action (e.g., hopping in place). The dependent measure was infants' preference for the happy video. An inverted condition was included to rule out the possibility that infants' preference was based upon some low-level perceptual feature (such as speed of movement), as this information remained constant in the inverted condition as well as in the upright condition. Previous studies have found that inversion disrupts the processing of faces and bodies for both infants and adults (Bhatt, Bertin, Hayden, & Reed, 2005; Reed et al, 2003; Yin, 1969; Zieber et al., 2010).

Method

Participants. Thirty-two 6.5-month-old infants (15 males; $M = 198.97$ days; $SD = 7.96$) from predominantly middle-class, Caucasian families participated in Experiment 1. Infants were recruited from local birth announcements and from a local hospital. Data from an additional infant were excluded due to side bias (greater than 90% looking to one side across the two trials).

Stimuli. The video clips used were displays of happy and neutral body actions that adults classified at accuracy levels over 85% (with chance being 20%) in Atkinson et al. (2004) and Atkinson et al. 2007 (see Figure 6.1). In the Atkinson (2004) study, the male and female professional actors were videotaped while they enacted each basic emotion in whatever manner they deemed appropriate. Subjects viewed these expressions and were asked to identify the emotion portrayed by the body movements in a forced-

choice task. In Atkinson et al. 2007, these emotional expressions were edited to 3-s video clips and a set of neutral stimuli were created and rated in a similar same manner.

In the current study, only videos of the happy and neutral actions were used. Four different happy/neutral actor pairs (two male pairs, two female pairs) were created. The happy and neutral body expressions were presented side by side on the screen and the videos played simultaneously (see Figure 6.1). The 3-s clips repeated 5 times, for a total of 15-s of video on each of two trials. Inverted stimuli were the same videos rotated 180°. Only visual information was provided by the videos; i.e., they were silent.

Apparatus and Procedure. Infants were seated approximately 45-cm from a 50-cm computer monitor in a darkened chamber. A video camera and a DVD recorder recorded infants' looks. Infants first saw a red flashing star located centrally on the computer monitor and each trial began when the infant fixated the center and the experimenter pressed a key. Then, a pair of images appeared side by side on the screen for 15-s. The initial left-right position of the happy body was counterbalanced across infants, and this position was switched on the second trial. Infants were assigned to either the upright or the inverted condition, and to one of the four actor pairs. The dependent measure was the percent preference for the happy video across the two trials. This was calculated in the following manner: the sum of the total looking time (s) to the happy body across the two trials was divided by the sum of the total looking time (s) to both the happy and the neutral body across the two trials; this ratio was multiplied by 100.

Coding of the infants' performance was conducted offline by a naïve coder unaware of the left-right location of the stimulus patterns, and with the DVD player

slowed to 25% of the normal speed. Coding reliability was verified by a second coder for 25% of the infants (Pearson's $r = .97$).

Results and Discussion

Infants demonstrated a preference to view the happy rather than the neutral videos in the upright condition ($M = 65.87\%$) that was significantly greater than the chance level of 50%, $t(15) = 3.67, p < .002$ (see Table 6.1). If infants' preference for the upright happy video was based solely upon differences in low-level perceptual features (e.g., a greater amount of movement in the happy video), then the infants' performance in the inverted condition should not significantly differ from the upright condition. However, infants in the inverted condition failed to show a significant preference ($M = 53.21\%$; $t(15) = 1.17, p > .05$). Additionally, infants' score in the upright condition was significantly greater than the score in the inverted condition, $t(30) = 2.48, p < .01; d = .87$. This indicates that the preference to view happy videos was not driven by low-level features such as a greater amount, size, or speed of movement (as these features were present in both the upright and inverted images). These results suggest that infants are capable of discriminating emotion conveyed by the body and prefer body actions that convey emotional (happy) over neutral actions.

However, while Experiment 1 demonstrated that infants discriminate happy from neutral body actions, I cannot conclude that this preference is based upon affective understanding per se. Just as young infants may be biased to attend to an invariant configuration of features associated with a particular facial expression (e.g., toothy smile, widened eyes), it may be that infants have a predisposition to view features associated with happy body expressions (e.g., bouncy rhythm, relaxed body) that does not require

affective understanding. (However, the inversion effect found in Experiment 1 seems to make this explanation less plausible.) In the emotion processing literature, the term “discrimination” is used to imply the ability to tell the difference between two emotions, but does not necessarily imply “recognition” of the specific emotions expressed. Recognition requires a deeper understanding; that is, the comprehension that an emotional expression is reliably associated with certain types of actions or situations (Walker-Andrews, 1997; Walker-Andrews, Krogh-Jespersen, Mayhew, & Coffield, 2011). Experiment 1 provides evidence that infants discriminate happy versus neutral body expressions, similar to previous studies demonstrating that infants’ discriminate happy and neutral facial and vocal expressions (Kuchuk et al., 1986; LaBarbera et al., 1976; Walker-Andrews & Grolnick, 1983). However, in order to extend the findings from Experiment 1, Experiments 2A and 2B addressed two issues: (a) whether infants discriminate between two different emotions (happy and angry) displayed by bodies, and (b) whether they go beyond discrimination to exhibit affective knowledge.

Table 6.1

Infants' Look Durations to the Videos and Mean Preferences for the Happy Body Expression in Experiment 1.

Orientation	N	Mean	Mean	Preference (%)	
		Looking Time (sec)	Looking Time (sec)	M	(SE)
<u>Experiment 1:</u>					
<i>6.5-month-olds</i>					
		<u>Happy</u>	<u>Neutral</u>		
Upright	16	17.15	9.25	65.87*	(4.32)
Inverted	16	14.18	12.55	53.21	(2.74)

* $p < .002$, 2-tailed; compared to 50% chance performance.



Figure 6.1. Examples of still frames taken from videos of neutral (left) and happy (right) body actions that infants viewed in Experiment 1. The female pair (top) depicts a woman jumping in place (left) and a woman jumping in a happy manner (right). The male pair (below) shows a man walking in place (left) and a man in the midst of a happy jump (right). Infants were assigned to view one of four happy-neutral pairs (2 male, 2 female) used in Experiment 1.

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Chapter 7: Intermodal Perception of Emotion

It is generally accepted that it is not until sometime between 5-7 months of age that infants recognize basic facial emotions viewed in static images of faces (Kestenbaum & Nelson, 1990; Ludemann, 1991; Ludemann & Nelson, 1988; Nelson & Dolgin, 1985; Nelson et al., 1979). However, in studies that have used emotions presented in a bimodal context and/or dynamic expressions, researchers have concluded that even younger infants display evidence of affective understanding. In a 2007 study, Flom and Bahrick investigated infants' ability to perceive affect conveyed in unimodal visual, unimodal auditory, or bimodal audio-visual stimuli. In the bimodal stimulation study, infants were habituated to a dynamic video of a female who conveyed one of three emotions (happy, angry, sad) by reciting a script in a manner consistent with the specified emotion. At test, they were presented with the same woman presenting a different emotion. The unimodal visual and unimodal auditory stimulation experiments used the same stimuli, except in the unimodal visual condition, infants were only presented with the visual information at habituation and test, and in the unimodal auditory condition, infants heard the same information but viewed a static (rather than dynamic) image of a face conveying a neutral expression during habituation and at test. They found that infants as young as 4 months of age discriminated the change of affect when viewing the bimodally (visual, audio) specified stimuli, but only 5- and 7-month-old infants discriminated in the unimodal auditory condition, and only the 7-month-olds discriminated the change in affect with unimodal visual stimuli (Flom & Bahrick, 2007). These findings underscore the significance of multimodal information for infants' discrimination of emotion, and they are consistent with the intersensory redundancy hypothesis (IRH), which posits that

infants' learning is facilitated by information that is redundantly specified across modalities. The IRH predicts that infants' detection of perceptual correspondences allows them to first learn about social events that contain multimodal information; later, as infants' processing of perceptual information becomes more flexible, they are able to also learn about social events even when information is presented in only one modality (Bahrick, Lickliter, & Flom, 2004).

In order to examine infants' knowledge of affective displays in a multimodal context, many studies have adapted the intermodal preference technique (Spelke, 1976). In this technique, infants simultaneously view two videos of dynamic facial expressions (presented side by side) while hearing an auditory recording that matches one of the filmed facial expressions. If infants look longer to the emotionally congruent video, then this is considered evidence that infants detect the common affective information (Walker-Andrews, 1997). Utilizing this method, several studies have found that between the ages of 5 and 7 months (if not earlier), infants match facial and vocal expressions of emotion based upon affect (Soken & Pick, 1992; Walker, 1982; Walker-Andrews, 1986, 1988). In a recent study using the intermodal preference technique, 6-month-old infants matched affective canine vocalizations (i.e., an aggressive versus a non-aggressive bark) to static images of the appropriate canine facial expressions, indicating impressive sensitivity to bimodally specified affective information even across species (Flom, Whipple, & Hyde, 2009). Thus, Experiment 2A utilized the intermodal preference technique with a group of 6.5-month-old infants to see if infants would also match emotional vocalizations to affective body movements.

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Chapter 8: Experiment 2A

In Experiment 2A, 6.5-month-old infants heard either a happy or an angry nonverbal vocalization (such as laughing or grunting) while viewing happy and angry body movement videos presented side by side. Infants' preference for the congruent body movement was assessed. Because infants are highly sensitive to information that is redundantly specified across modalities (e.g., synchrony), an inverted condition ensured that matching was not based solely upon this type of low-level feature. Matching only in the upright condition would suggest that infants recognize the common affect portrayed in the different modalities, indicating that infants are sensitive at least to some extent to the affect conveyed in body expressions (Atkinson et al., 2007; Flom & Bahrick, 2007; Flom et al., 2009).

Method

Participants. Subjects were thirty-two 6.5-month-olds (14 males; $M = 194.16$ days; $SD = 8.38$). Data from an additional infant were excluded due to side bias. As in previous experiments, infants were recruited from birth announcements and through a local hospital.

Stimuli. As in Experiment 1, four pairs of silent videos of angry and happy body movements were taken from Atkinson et al. (2004) (see Figure 8.1). However, in Experiment 2A, a happy or angry nonverbal vocalization [adapted from Sauter et al. (2010), which demonstrated accurate recognition of these recordings by adults from different cultures] played with each repetition of the video clip (i.e., 5 repetitions in the 15-s trial). Four vocalizations (2 happy, 2 angry) were chosen while matching to the gender of the body pairs. Each pair of happy/angry videos was equally often

accompanied by a happy or angry sound, so that each video was equally often the matching and non-matching stimulus.

Apparatus and Procedure. The apparatus was the same as in Experiment 1. The intermodal preference technique (Spelke, 1976) was used to present a happy and an angry video side by side while infants heard either a happy or angry vocalization presented from two centrally located speakers. Infants were assigned to either an upright or inverted condition; half of the infants heard a happy vocalization while the other half heard angry vocalizations (while viewing silent happy and angry videos side by side). Within each group, the happy/angry video was equally often in the left/right position and switched position across the two 15-s test trials. Moreover, each happy and angry video was equally often a matching or non-matching video. The dependent measure was infants' percent preference for the emotionally congruent video across the two trials.

Results and Discussion

An outlier analysis using SPSS 20 revealed that the preference scores of two participants in the upright condition were outliers. These data were not included in the following analyses. There were no outliers in the inverted condition. Infants in the upright condition displayed a significant preference for the congruent video, $M = 57.95\%$; $t(13) = 3.83$, $p < .002$ (see Table 8.1). Infants in the inverted condition failed to demonstrate a preference, $M = 49.07\%$; $t(15) = -.19$, $p > .05$. [Also, the difference between the score in the upright versus the inverted condition was approaching significance, $t(28) = 1.56$, $p < .13$; $d = .59$]. This indicates that the preference in the upright condition was not due to low-level features (such as amount of movement, or

rhythm). Thus, infants in Experiment 2A discriminated between two different emotions conveyed by body movements and matched them to corresponding vocal emotions.

As in previous studies demonstrating that infants match vocal expressions of emotion to facial emotions, the 6.5-month-old infants in Experiment 2A matched emotional vocal expressions to emotional body movements. However, the question arises as to whether this ability is present earlier in infancy, or if it is the case that younger infants lack this ability but a developmental change occurs sometime before 6.5 months of age. Therefore, Experiment 2B addressed this question by using the same procedure with a group of 3.5-month-old infants. Based on other studies that have only found intermodal matching for facial and vocal expressions of emotion with infants 4 months or older, it was predicted that infants would not match the affective vocalizations to body movements (Soken & Pick, 1992, 1999; Walker, 1982; Walker-Andrews, 1986). However, a few studies have found that even 3.5-month-old infants match facial and vocal expressions of emotion under certain conditions (Montague & Walker-Andrews, 2002), so it is possible that 3.5-month-olds will discriminate the emotional body movements using the intermodal preference technique.

Table 8.1

Infants' Look Durations to the Videos and Mean Preferences for the Congruent Body Expression in Experiments 2A & 2B.

	Orientation	N	Mean Looking Time (sec)	Mean Looking Time (sec)	Preference (%) M (SE)
<u>Experiment 2A: 6.5-month-olds</u>					
<i>Happy versus Angry</i>	Upright	14	<u>Congruent</u> 15.86	<u>Incongruent</u> 11.99	57.95** (2.07)
	Happy	6	16.21	12.04	62.04** (2.02)
	Angry	8	15.50	11.96	54.88* (2.94)
	Inverted	16	13.59	13.86	49.07 (4.98)
	Happy	8	11.75	16.35	41.48 (7.27)
	Angry	8	15.43	11.36	56.65 (6.09)

** $p < .002$, 2-tailed; compared to 50% chance performance.

* $p < .14$, 2-tailed; compared to 50% chance performance.



Figure 8.1. Examples of still frames taken from a female pair (top row) and a male pair (bottom row) used as stimuli in Experiments 2A and 2B. Infants viewed one of four angry-happy body pairs; in the above pairs, angry body movements appear on the left and happy body movements are on the right.

Chapter 9: Experiment 2B

Method

Participants. Thirty-two 3.5-month-old infants (23 males; $M = 104.81$ days; $SD = 8.54$) from predominantly middle-class, Caucasian families participated in Experiment 2B. As in previous experiments, infants were recruited from birth announcements and through a local hospital.

Stimuli, Apparatus, and Procedure. The stimuli and procedure used were the same as those used in Experiment 2A. Again, the dependent measure was the percent preference for the emotionally congruent video across the two trials. However, I felt that younger infants might fail to match emotional body movements to sounds within the time limits used in Experiment 2A because they are slower to process the information (rather than because they lack the ability to do so). Therefore, 2 additional 15-s trials were included in the procedure to investigate this possibility. Thus, infants saw 4 consecutive 15-s test trials in Experiment 2B. Infants were assigned to either an upright or inverted condition, and to one of four body pairs. The initial left-right position of the congruent body was counterbalanced across infants, and the position of the congruent body switched across the 4 trials such that it was presented on the left and right equally often.

Coding of the infants' performance was conducted as in Experiment 2A. Coding reliability was verified by a second coder for 25% of the infants (Pearson's $r = .99$).

Results and Discussion

Infants' preference for the emotionally congruent video was assessed in the same manner as in Experiment 2A by computing the percentage of total looking time to the

congruent video across two test trials. An outlier analysis using SPSS 20 revealed that the preference scores of four participants in the inverted condition were outliers. These data were not included in the following analyses. There were no outliers in the upright condition. Infants in the upright condition displayed a marginally significant preference for the *incongruent* video, $M = 36.63\%$; $t(15) = -1.88$, $p < .08$ (see Table 9.1). Infants in the inverted condition failed to demonstrate a preference, $M = 50.73\%$; $t(11) = .76$, $p > .05$. Also, the score in the upright condition was marginally significantly greater than the score in the inverted condition [$t(26) = -1.70$, $p < .11$; $d = .23$].

However, because the upright preference score was only marginally different from 50% chance, and the difference between performance in the upright and the inverted conditions was also only marginally significant, I extended our analyses to examine the percent preference for the congruent video across all 4 trials. In these analyses, the dependent measure was (again) infants' percent preference for the congruent video; however, this was calculated by dividing the sum of infants' looking time (s) to the congruent video across all 4 trials by the sum of infants' total looking time (s) to both the congruent and incongruent videos across all 4 trials, then multiplying this ratio by 100. Again, infants in the upright condition looked longer to the incongruent video, $M = 35.54$, $t(16) = -3.06$, $p < .008$ (see Table 9.1). In the inverted condition, infants' score did not differ from chance performance, $M = 49.16$, $t(12) = 49.16$, $p > .05$. The difference between performance in the upright and inverted conditions was also significant, $t(26) = -2.34$, $p < .03$.

Thus, when 3.5-month-olds' data were evaluated in the same manner as the 6.5-month-olds (across two 15-s test trials), their results were trending toward significance.

However, when I extended the analyses to assess 3.5-month-olds' performance across all four 15-s test trials, infants significantly preferred the incongruent body actions in the upright condition, but not in the inverted condition (see Figure 9.1). This suggests that the preference in the upright condition was not due to low-level features (such as amount of movement, or rhythm). Thus, in Experiment 2B 3.5-month-old infants discriminated between two different emotions conveyed by body movements and their visual preference was based upon the emotional vocalizations, indicating knowledge of the common affect expressed in different modalities.

However, the finding that the younger infants preferred to view the body movements that did not correspond to the vocalized emotion (as opposed to the emotionally congruent body movements) was unexpected. While most studies using the intermodal preference technique have found infants' prefer to look at the congruent stimuli (Walker, 1982; Walker-Andrews, 1986; Soken & Pick, 1992), some studies have found that infants' prefer to view the incongruent stimuli in some situations (Bahrick, 1983; Flom et al., 2009; Montague & Walker-Andrews, 2002; Rochat & Morgan 1985; Schmuckler & Fairhall, 2001). Additionally, several of these studies have found the preference for the emotionally congruent or incongruent stimuli to differ across age groups or conditions within the same study (Bahrick, 1983; Flom et al., 2009; Montague & Walker-Andrews, 2002). Nonetheless, it has been concluded that in both situations, infants' performance could only have been based upon the detection of correspondences across the two modalities.

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Table 9.1

Infants' Look Durations to the Videos and Mean Preferences for the Congruent Body Expression in Experiment 2B.

	Orientation	N	Mean Looking Time (sec)	Mean Looking Time (sec)	Preference (%) M (SE)
Experiment 2B:					
<i>3.5-month-olds</i>					
<i>(2-trial data)</i>					
	Upright	16	<u>Congruent</u> 10.81	<u>Incongruent</u> 17.80	36.63* (7.10)
	Happy	8	10.27	17.94	34.48 (9.66)
	Angry	8	11.34	17.67	38.79 (11.03)
	Inverted	12	14.19	13.70	50.73 (0.96)
	Happy	6	14.57	14.56	49.97 (0.46)
	Angry	6	13.82	12.84	51.47 (1.91)
	Upright	16	<u>Congruent</u> 20.40	<u>Incongruent</u> 36.76	35.54*** (4.72)
	Happy	8	20.24	36.49	35.65** (4.67)
	Angry	8	21.30	37.02	35.44* (8.59)
	Inverted	12	27.56	28.65	49.16 (2.27)
	Happy	6	27.61	30.34	47.65 (1.72)
	Angry	6	27.51	26.96	50.67 (4.34)

*** $p < .01$, 2-tailed; compared to 50% chance performance.

** $p < .05$, 2-tailed; compared to 50% chance performance.

* $p < .14$, 2-tailed; compared to 50% chance performance.

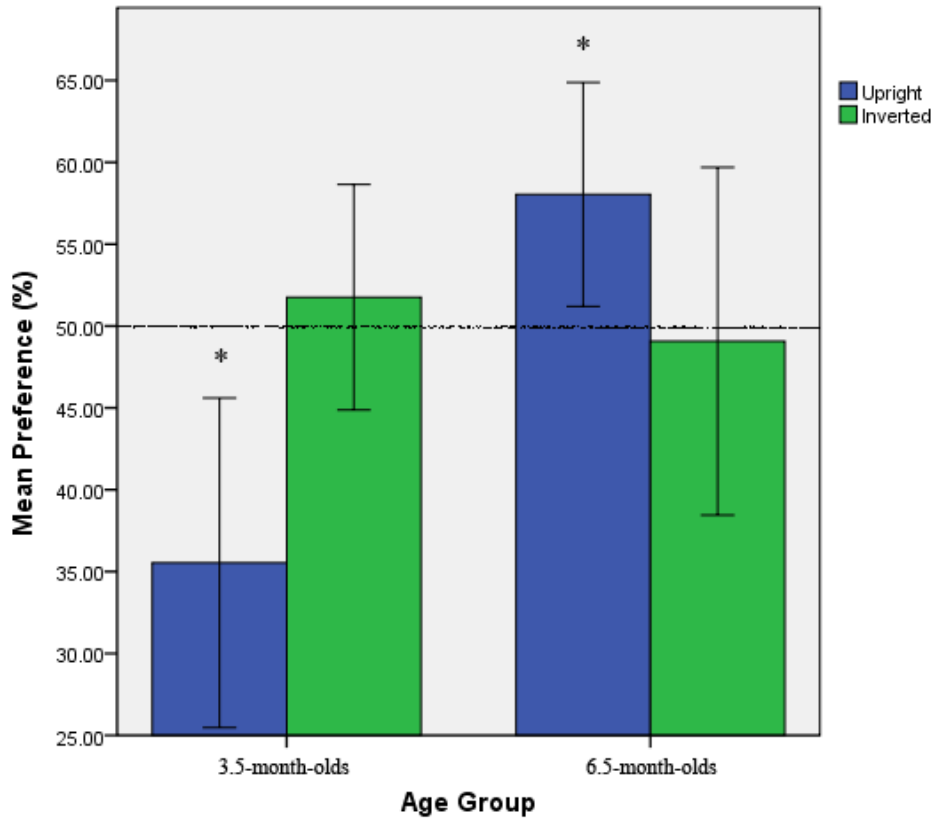


Figure 9.1. Infants' mean percent preference for the emotionally congruent body movements in Experiment 2A (right) and Experiment 2B (left). In Experiment 2A, the older infants preferred to view the emotionally congruent video in the upright condition ($M = 57.95\%$; $p < .002$) but not in the inverted condition ($M = 49.07$; $p > .85$).

In Experiment 2B, however, (across the 4 test trials) the younger infants preferred to view the emotionally *incongruent* video in the upright condition ($M = 35.54\%$; $p < .002$) but did not demonstrate a preference in the inverted condition ($M = 49.16\%$; $p > .72$).

Note: $*p < .01$; when compared to 50% chance.

Chapter 10: General Discussion

Like adults, 3.5 and 6.5-month-old infants are sensitive to emotions exclusively portrayed through body movements. Infants of 6.5 months of age prefer to view an actor performing an emotional action to a neutral action (Experiment 1) and are able to discriminate between two emotions (happy and angry) conveyed in body movements and match them to appropriate emotional sounds (Experiment 2A). The infants do not exhibit preferences and fail to match sounds to actions when the exact same stimuli are inverted, indicating that preference in the upright conditions was not driven by some general stimulus property unrelated to affect. Additionally, Experiment 2B demonstrates that sensitivity to emotions conveyed by body movements is present by 3.5 months of age.

Infants' Preference for Emotional Body Movement

In Experiment 1, 6.5-month-old infants demonstrated a preference to view happy body movements over neutral body movements. Although amount of movement was equated as much as possible, in principle, differences in amount or some other low-level aspect of movement could have driven infants' preference. It may be that happiness, by definition, is characterized by more exaggerated or rapid movements and that this is what directed infants' attention to the happy actions. However, when these actions were inverted, the amount of movement as well as the size of the gestures was the same, but infants failed to demonstrate a preference. This indicates infants' performance was not solely based upon this type of low-level feature, and that infants viewed the actions in the upright condition as meaningful body movements.

While infants preferred emotional body gestures to neutral actions, it is important to note that Experiment 1 tested only one emotion (happy), and it may be that there are

other emotions that infants would not prefer over neutral (e.g., sad body movements). This may be because a particular emotion (like sadness) is less salient when conveyed through body expressions (as compared to its facial expression) or because of the valence of a particular emotion. Future research should determine the similarities and differences in how distinct emotions are perceived by infants when conveyed in bodies, as well as how this relates to infants' perception of facial expressions of emotion.

Infants Utilize Affective Information to Discriminate Emotional Body Movements

After finding that infants prefer to view happy versus neutral body movements in Experiment 1, Experiments 2A and 2B were conducted to extend this finding by asking infants to distinguish between two discrete emotions and to match them to corresponding vocalizations. Experiments 2A and 2B utilized the intermodal preference technique, a method that requires infants to detect perceptual correspondences between affective information presented in two sensory modalities in order to match the vocalized emotion to the corresponding body movement (e.g., Flom et al., 2009; Kahana-Kalman & Walker-Andrews, 2001). The 6.5-month-old infants in Experiment 2A exhibited an impressive ability to match affective vocalizations to body movements; infants who heard the angry vocalization preferred to view the angry video, whereas infants who heard the happy vocalization preferred to view the happy video. (Thus, despite the fact that separate groups of infants saw the exact same happy/angry body pair, infants who viewed the pair while hearing an angry vocalization looked longer to the angry body, but infants who viewed the same pair while hearing a happy vocalization looked longer to the happy body). This result is consistent with previous studies that have found infants are sensitive to affect conveyed across two modalities by this age. By 7 months of age, infants are able

to match facial and vocal expressions of emotion, even if they are presented out of sync (Walker, 1982) or if the mouth is obscured so that matching based upon lip-voice synchrony is not possible (Walker-Andrews, 1986).

Intermodal Matching

Yet is it possible infants were merely matching based upon some type of common information specified across the two modalities that is unrelated to affective meaning? Infants are extremely sensitive to information that is redundantly specified across modalities (such as tempo, rhythm, synchrony) and even newborns find these characteristics to be highly salient (Lewkowicz, Leo, & Simeon, 2010). This type of information is considered amodal because it is not specific to one modality [whereas modality-specific information is only perceivable through one sensory channel (e.g., color)]. One particularly salient amodal property is synchrony, and in the present study, it could be that infants matched based upon synchrony between the vocalization and the body movements. Previous studies have demonstrated that younger infants will *only* demonstrate intermodal matching for temporally synchronous affective facial and vocal expressions, whereas older infants can match the emotional expressions even when they are delayed by several seconds (Soken & Pick, 1992; Walker, 1982). However, these studies utilized videotaped dynamic expressions with the same person enacting the facial and vocal expression, while the current study used videotaped body actions and emotional vocalizations adapted from different studies with adults. In most of the former studies, infants in the synchronous condition were able to match based upon direct correspondences between lip movements and vocalizations, but in the latter there were no direct correspondences between the body actions in the video and the vocalizations (i.e.,

the actors in the videos were not making the happy/angry vocalizations while enacting the emotion), indicating infants' performance could not be solely based upon matching synchronous features.

However, it is also important to note that utilization of amodal information to discriminate emotion does not necessarily mean that performance is not based on affect-specific information. Certain amodal characteristics might help to define different emotions; for example, happy may be associated with a light or bouncy tempo while angry may be identified by a rigid or tense tempo. While qualities such as these may be visually perceived from the dynamic body movements, they may also be present in the vocalization, which becomes clear when viewing the differences in energy and signal distribution in the oscillograms and spectrograms of the emotional vocalizations used in Experiments 2A & 2B (see Figure 10.1).

These qualities may be perceivable across both visual and auditory modalities, but if intermodal matching was only based upon the detection of such qualities, a similar ability would be demonstrated when the images are inverted. The inversion of stimuli has been used in previous studies utilizing the intermodal preference technique as a means of controlling for performance based upon amodal properties such as temporal synchrony or rate information (Flom et al., 2009; Walker, 1982). In the present study, even if the videos and vocalizations shared a common feature (e.g., tempo), the presence of an inversion effect overruled the possibility that the preference was based upon this type of low-level feature.

Young Infants' Discrimination of Affective Information

In Experiment 2B, 3.5-month-old infants used affective information to detect correspondences across both modalities, and preferred to view the emotionally incongruent body movements when they were presented upright, but not when they were inverted. While it was predicted that 3.5-month-olds would not detect the intermodal correspondences between the affective vocalizations and body movements, there have been some studies that have found younger infants match affective facial and vocal expressions under certain conditions. Using the intermodal preference technique with a group of 3.5-month-old infants, Montague and Walker-Andrews (2002) found that when facial and vocal displays were presented by a familiar individual (their mother), infants displayed intermodal matching but that infants failed to match affective content when the displays were modeled by an unfamiliar individual. Another study found infants demonstrate intermodal matching sometime between 4-6 months of age for gender information conveyed in the face and voice (Walker-Andrews, Bahrick, Raglioni, & Diaz, 1991). Other studies utilizing dynamic, bimodally presented information have found that 4-month-olds (but not 3-month-olds) discriminated happy, sad, and angry expressions even when modeled by unfamiliar individuals (Flom & Bahrick, 2007). Thus, while the current findings were unexpected, several studies have found that young infants match information from different modalities sometime between 3-6 months of age.

The current study was the first to investigate intermodal matching for affective body information, and another explanation for the findings with 3.5-month-olds may be that it is an easier task for infants to match affective vocalizations to bodies than it is for them to match vocalizations to faces. This may be the case because infants' strong a

priori preferences for faces sometimes interfere with their performance, whereas the type of body stimuli used in the current study minimized the amount of individuating information that might tap into infants' a priori preferences. Numerous studies testing for discrimination of emotional faces have found order effects, such that an a priori preference for the habituated expression (e.g., happy) overrides the novelty preference at test (Ludemann & Nelson, 1988; Nelson & Dolgin, 1985; Nelson et al., 1979). Additionally, Soken & Pick (1992) found that 6.5-month-old infants failed to discriminate facial emotion in a fully-lit (typical) face, but did discriminate when they limited facial information to a point-light-display of a face. They found that infants' preference for the happy expression in the fully-lit condition led to the null result, but when the same affective expression was limited to motion information, infants demonstrated intermodal matching to the corresponding facial expressions for both happy and angry vocal expressions. Thus, when utilizing body (and in particular, dynamic body) displays rather than facial displays, infants may demonstrate ability to match affective vocalizations at an even younger age than previously documented for facial and vocal expressions.

Another unexpected finding in Experiment 2B was 3.5-month-olds' preference to view the incongruent body expressions as opposed to 6.5-month-olds' preference to view the emotionally congruent body movements. It is puzzling as to why this might occur, but it is not unprecedented in the literature. Montague and Walker-Andrews' (2002) found that infants preferred to view the congruent facial expression when tested with happy/sad pairs in an intermodal preference task, but the same infants preferred to view the incongruent facial expression when tested with happy/angry pairs. One proposed

explanation is that infants' preference for an incongruent emotional pairing may indicate discrimination between emotions without recognition of the underlying affective meaning (Montague & Walker-Andrews, 2002). Some have argued that it may be particularly difficult for infants to generalize across individual exemplars of happy or angry and to recognize these emotions from each other; therefore, it is not until later in development, after infants' have had sufficient experience with both, that they recognize these expressions as meaningful (Caron et al., 1985; Montague & Walker-Andrews, 2002). This line of reasoning would suggest that, in the present study, it may be that younger infants are able to detect the corresponding affective information specified across modalities (which requires at least some level of affective knowledge); however, only the older infants associate the appropriate meaning with each display and therefore prefer to view the emotionally congruent images.

However, another possibility is that infants *do* recognize the meaning conveyed. It has been suggested that infants' looking preferences may be different for emotions that vary greatly in their social-signal value (Schwartz et al., 1985; Montague & Walker-Andrews, 2002). Happy expressions tend to signal that the caregiver is open to interaction, whereas a caregiver's angry expressions tend to be aversive to young infants (Montague & Walker-Andrews, 2002). It may be that for younger infants, experiencing happy in the presence of angry diminishes the signal value of the emotion happy. According to this argument, if happiness is no longer an unambiguous signal for interaction when paired with anger, infants may prefer to view the more novel, incongruent image (Schwartz et al., 1985). However, as older infants have more experience with anger [the amount of exposure to anger is thought to greatly increase

once an infant starts crawling- see Campos, Kermoian, & Zumbahlen, 1992], the simultaneous conflicting signals presented by anger and happiness do not interfere with the preference for the congruent image. However, in Experiment 2B, infants' preference to view the incongruent image may or may not be attributed to one of these two explanations. Further studies are necessary to uncover the meaning behind the preference for the incongruent in the current context.

Implications for Future Research

The question remains as to what meaning infants are extracting from these emotional displays. It is clear that infants' performance is based upon affective knowledge of the emotions presented; however, whether this performance indicates an adult-like understanding of the emotions presented or some intermediate level of affective understanding is still unclear. In order to assess whether infants truly understand the meaning of an emotional display requires evidence that the infant has changed their own emotional behavior in response to the affective meaning conveyed. In the current study, the question of whether infants would respond appropriately to different emotions was not assessed. Therefore, while I can conclude infants display knowledge of the meaning behind happy and angry body expressions in that they recognize affective characteristics of each emotion across visual (body) and auditory (vocal) modalities, I cannot say for certain that infants would respond appropriately to such information. There have been previous studies that have found 4-month-old infants respond appropriately to live models' facial and vocal expressions of happiness/surprise, anger, fear and sadness (Montague & Walker-Andrews, 2001). Thus, it is plausible that this kind of affective knowledge would allow infants to correctly interpret the body movements

and respond in a fitting manner, but future research will have to investigate this possibility in order to document infants' capabilities.

While no current theory of emotion has made any predictions regarding the development of emotion processing from bodies specifically, the present findings supplement previous work that has found infants are sensitive to emotion conveyed through facial and vocal expressions. Additionally, the current study indicates that infants, like adults, are sensitive to emotion (in particular, anger and happiness) portrayed in body movements. The fact that young infants extract emotion information from both faces and bodies falls in line with DET, which suggests there are universals in the expression of emotion that are understood across different cultures, and that this universal nature (combined with the evolutionary significance of basic emotions) suggests that perception of some emotions develops early in life. The fact that infants' recognize basic emotional expressions portrayed by faces, bodies, and vocalizations also supports the idea that basic emotions are distinct in their expression and meaning.

This research has provided a starting point for investigating infants' abilities to process emotion from bodies, and has important implications for other areas of research as well. Meltzoff's (2005) "Like me" hypothesis suggests that infants reflexively imitate the behavior of others in their environment, and through this perception as well as production of another's behavior, eventually learn about the mindset and intentions of other individuals. Further study into how infants perceive not only others' actions and goals, but also how infants perceive the significance of another individual's movements (e.g., the flailing arms associated with anger may be a cue to keep your distance) is needed to understand how infants develop competence at interpreting this type of signal.

Additionally, the discovery of mirror neurons (in particular, mirror neurons that respond to affect), which fire both when an individual executes an action as well as when they view another individual enacting that action, has presented a possible mechanism behind the development of affective understanding in infancy. Researchers have concluded that self-production of actions plays an integral part of learning about action perception (Del Guidice et al., 2009) and future research conducted with younger infants or infants with different levels of motor development may provide insight into this possibility. By understanding how infants develop the ability to perceive affordances from another's emotional actions, we may gain insight into these other emerging areas of research as well.

Concluding Remarks

In conclusion, it is impressive that 3.5- and 6.5-month-olds were able to discriminate between body emotions when only body (as opposed to facial) emotion information was present. The 6.5-month-olds preferred to view happy versus neutral body movements (Experiment 1), and the inversion effect demonstrated this preference was not based upon low-level features. Both age groups discriminated happy and angry emotional body movements (Experiments 2A & 2B); however, while 6.5-month-olds matched the emotional vocalizations and body movements in the upright condition, 3.5-month-olds preferred to view the video of the incongruent body emotion. While this was unexpected, in both cases, infants only exhibited a preference when the emotion was conveyed in canonical, meaningful body movements, as opposed to the inverted body movements. This suggests both 3.5- and 6.5-month-old infants' preferences were based on detection of affective information specified across modalities, rather than upon some

low-level feature (such as rhythm or synchrony). Additionally, the 6.5-month-old infants performed similarly as in studies where infants matched facial and vocal affect using the intermodal preference technique, an ability that has been interpreted as sensitivity to the meaning conveyed by the emotion. These findings demonstrate that infants derive information about people's emotional states from their body actions, which indicates that sophisticated emotion processing capabilities are evident quite early in life.

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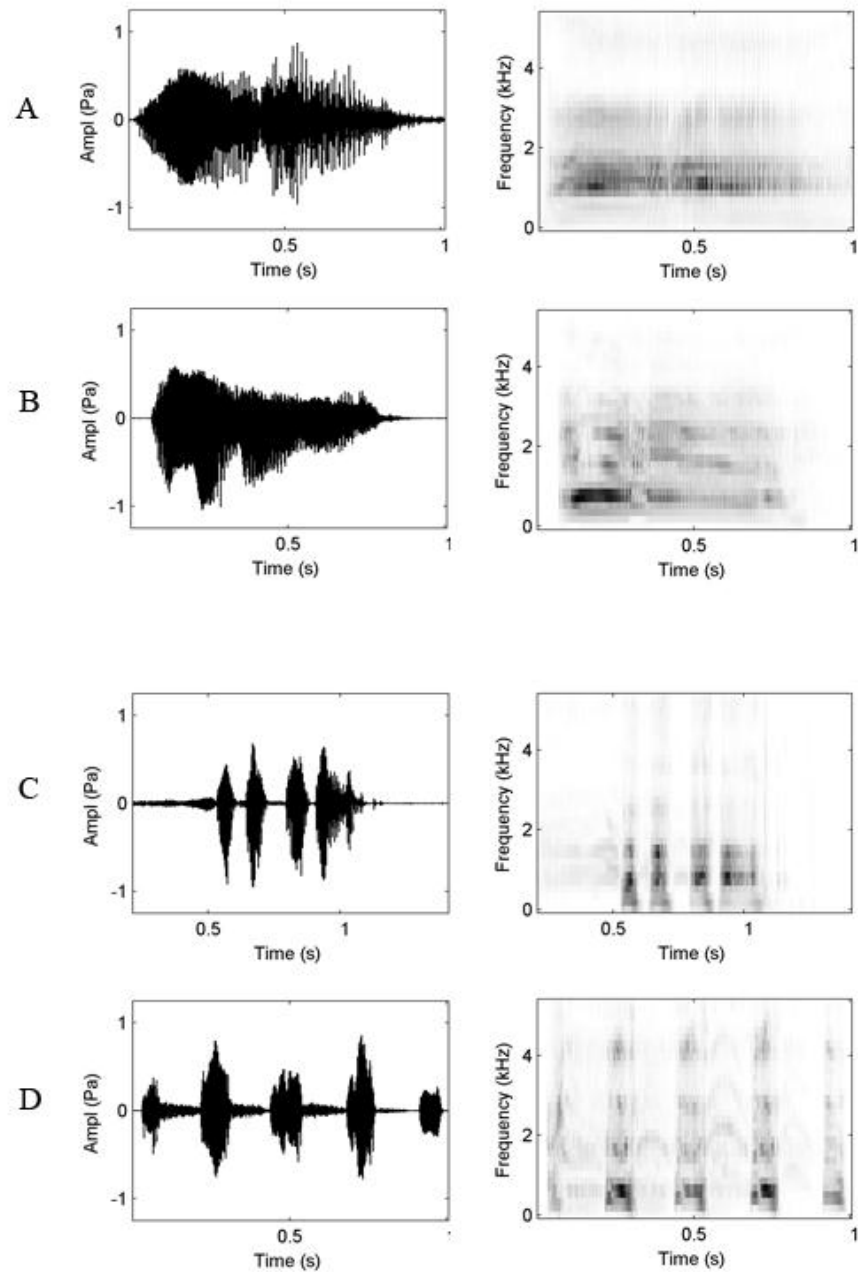


Figure 10.1. Oscillograms (left) and spectrograms (right) for 0.8 sec of each of the four vocalizations used. The 0.8 sec of each vocalization depicted represent the “peak” of the emotional expression. The graphs in lines A & B represent angry vocalizations (for one male, A; and for one female, B) while the graphs in lines C & D represent happy vocalizations (for one male, C; and for one female, D).

[Note: In the oscillograms, the amplitude is expressed in volts; in the spectrograms, the frequency in kilohertz is presented.]

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MANUSCRIPTS SUBMITTED

Hayden, A., Bhatt, R.S., Kangas, A., **Zieber, N., & Joseph, J.E. (under review).** Emotion is a fundamental feature of faces in infancy and its processing is independent of race.

Zieber, N., Kangas, A., Bhatt, R.S. & Hayden, A. (under review). Perceptual specialization and configural face processing in infancy.

Zieber, N., Kangas, A., & Bhatt, R.S. (submitted). Infants' perception of emotion from dynamic body expressions.

MANUSCRIPTS IN PREPARATION

Zieber, N., Kangas, A., & Bhatt, R.S. (in preparation). Is the head necessary to process body information in infancy?

Zieber, N., Kangas, A. & Bhatt, R.S. (in preparation). The emergence of body representation in early infancy.

PRESENTATIONS IN PROFESSIONAL MEETINGS

Zieber, N., Kangas, A. & Bhatt, R.S. (accepted). *Infants' perception of emotion from dynamic body movements.* Abstract submitted for paper symposium presentation at the 2012 biennial meeting of the International Society on Infant Studies, Minneapolis, Minnesota.

Zieber, N., Kangas, A. & Bhatt, R.S. (accepted). *Is the head necessary to process body information in infancy?* Poster submitted for presentation at the 2012 biennial meeting of the International Society on Infant Studies, Minneapolis, Minnesota.

Zieber, N., Kangas, A., Hoch, A. & Bhatt, R.S. (accepted) *Infants emerging body knowledge.* Poster submitted for presentation at the 2012 biennial meeting of the International Society on Infant Studies, Minneapolis, Minnesota.

Kangas, A., **Zieber, N. & Bhatt, R.S. (accepted).** *Processing of second-order facial information in infancy: The role of external features.* Poster submitted for presentation at the 2012 biennial meeting of the International Society on Infant Studies, Minneapolis, Minnesota.

Zieber, N. & Bhatt, R. (2011). *Infants' discrimination of gender from dynamic point-light displays.* Poster presented at the 2011 biennial meeting of the Society for Research in Child Development, Montreal, Quebec.

Zieber, N. & Bhatt, R. (2011). *The development of face expertise: The relationship between configural and holistic processing in infancy.* Poster presented at the 2011 biennial meeting of the Society for Research in Child Development, Montreal, Quebec.

- Bhatt, R.S., **Zieber**, N., Hayden, A., & Kangas, A. (2011). *Figural information is more salient than background information in infancy*. Poster presented at the 2011 biennial meeting of the Society for Research in Child Development, Montreal, Quebec.
- Hayden, A., Kangas, A., Bhatt, R.S., & **Zieber**, N. (2011). *The role of racial information in infant emotion processing*. Poster presented at the 2011 biennial meeting of the Society for Research in Child Development, Montreal, Quebec.
- Zieber**, N. & Bhatt, R. (2010, April). *Is the head necessary for body representation in infancy?* Poster session presented at the biennial meeting of the International Conference on Infant Studies, Baltimore, Maryland.
- Bhatt, R., Hayden, A., Kangas, A., & **Zieber**, N. (2010, April). *Infants processing of gender information*. Poster session presented at the biennial meeting of the Society International Conference on Infant Studies, Baltimore, Maryland.
- Zieber**, N., Hayden, A., & Bhatt, R. (2009, April). *Body representation in the first year of life*. Poster session presented at the biennial meeting of the Society for Research in Child Development, Denver, Colorado.
- Hayden, A., **Zieber**, N. & Bhatt, R. (2009, April). *Race-based perceptual asymmetries underlying face processing in infancy*. Poster session presented at the biennial meeting of the Society for Research in Child Development, Denver, Colorado.
- Hayden, A., **Zieber**, N. & Bhatt, R. (2008, March). *Infants' sensitivity to configural information in human male and monkey faces*. Poster session presented at the biennial meeting of the International Conference on Infant Studies, Vancouver, B.C.

LABS TAUGHT AS TEACHING ASSISTANT AT UNIVERSITY OF KENTUCKY

- Psychology 100 – Introduction to Psychology, 2007-2008, 2010, 2011
 Psychology 215 – Experimental Psychology, 2009
 Psychology 216 – Application of Statistics in Psychology, 2009
 Psychology 450 – Learning, 2010
 Psychology 460 – Processes of Psychological Development, 2009-2010
 Psychology 462 – Cognitive Processes, 2011

UNDERGRADUATE SUPERVISION

Honors Theses:

- Differences in the processing of relational information in own race versus other-race faces in infancy, 2008-2009.
- Are infants sensitive to emotion portrayed in body movements? 2010-2011.
- 7-month-old infants' discrimination of gender across different identities, 2010-2011.