

11-7-2011

# The Role of Contingency and Gaze Direction in the Emergence of Social Referencing

Mariana V. Molina

*Florida International University*, [mvail001@fiu.edu](mailto:mvail001@fiu.edu)

Follow this and additional works at: <http://digitalcommons.fiu.edu/etd>

---

## Recommended Citation

Molina, Mariana V., "The Role of Contingency and Gaze Direction in the Emergence of Social Referencing" (2011). *FIU Electronic Theses and Dissertations*. Paper 504.

<http://digitalcommons.fiu.edu/etd/504>

This work is brought to you for free and open access by the University Graduate School at FIU Digital Commons. It has been accepted for inclusion in FIU Electronic Theses and Dissertations by an authorized administrator of FIU Digital Commons. For more information, please contact [dcc@fiu.edu](mailto:dcc@fiu.edu).

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

THE ROLE OF CONTINGENCY AND GAZE DIRECTION IN THE  
EMERGENCE OF SOCIAL REFERENCING

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PSYCHOLOGY

by

Mariana Vaillant Molina

2011

To: Dean Kenneth Furton  
College of Arts and Sciences

This dissertation, written by Mariana Vaillant Molina, and entitled The Role of Contingency and Gaze Direction in the Emergence of Social Referencing, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

---

Mary Levitt

---

Martha Pelaez

---

Robert Lickliter

---

Lorraine E. Bahrack, Major Professor

Date of Defense: November 7, 2011

The dissertation of Mariana Vaillant Molina is approved.

---

Dean Kenneth Furton  
College of Arts and Sciences

---

Dean Lakshmi N. Reddi  
University Graduate School

Florida International University, 2011

## DEDICATION

I dedicate this dissertation to my son, Alec, who teaches me about learning and loving,  
and offers insights into an immensely creative period of the lifespan, childhood.

## ACKNOWLEDGMENTS

I would like to thank my committee members for their support, insightful comments, and enthusiasm in my work. I would like to thank my major professor, Dr. Lorraine Bahrck for her patience, guidance, and for encouraging me to strive for excellence. I also wish to acknowledge the Minority Biomedical Research Support fellowship, without which I could not have completed my graduate training. Finally, I wish to thank Melissa Argumosa and Irina Castellanos for their encouragement, good humor, and friendship, and my family for their unconditional love and support throughout my academic journey.

ABSTRACT OF THE DISSERTATION  
THE ROLE OF CONTINGENCY AND GAZE DIRECTION  
IN THE EMERGENCE OF SOCIAL REFERENCING

by

Mariana Vaillant Molina

Florida International University, 2011

Miami, Florida

Professor Lorraine E. Bahrick, Major Professor

The current study assessed the importance of infant detection of contingency and head and eye gaze direction in the emergence of social referencing. Five- to six-month-old infants' detection of affect-object relations and subsequent manual preferences for objects paired with positive expressions were assessed. In particular, the role of contingency between toys' movements and an actress's emotional expressions as well as the role of gaze direction toward the toys' location were examined. Infants were habituated to alternating films of two toys each paired with an actress's affective expression (happy and fearful) under contingent or noncontingent and gaze congruent or gaze incongruent conditions. Results indicated that gaze congruence and contingency between toys' movements and a person's affective expressions were important for infant perception of affect-object relations. Furthermore, infant perception of the relation between affective expressions and toys translated to their manual preferences for the 3-dimensional toys. Infants who received contingent affective responses to the movements of the toys spent more time touching the toy that was previously paired with the positive expression. These findings demonstrate the role of contingency and gaze direction in the emergence of

social referencing in the first half year of life.

## TABLE OF CONTENTS

| CHAPTER   | PAGE |
|---|------|
| I. INTRODUCTION.....  | 1    |
| II. METHODS AND MEASURES FOR EXAMINING INFANT PERCEPTION OF EMOTIONS..... | 6    |
| Infant Controlled Habituation.....  | 6    |
| Visual Preference Methods.....  | 11   |
| The Intermodal Matching Method.....                                       | 12   |
| The Still Face Paradigm and Other Methods of Social Interaction.....      | 14   |
| The Social Referencing Paradigm.....                                      | 16   |
| III. LITERATURE REVIEW.....   | 22   |
| Gaze Following and Joint Visual Attention.....                            | 23   |
| Contingency Detection.....  | 25   |
| Social Referencing.....   | 26   |
| Intersensory Redundancy and Attention to Stimulus Properties.....         | 29   |
| Test of the Role of Contingency and Gaze Direction.....                   | 31   |
| Hypotheses and Predictions.....   | 33   |
| IV. METHOD.....   | 39   |
| Participants.....   | 39   |
| Stimuli.....  | 39   |
| Apparatus.....  | 42   |
| Procedure.....  | 42   |
| V. RESULTS.....   | 47   |
| Visual Preference Pretest.....  | 47   |
| Habituation and Switch Test.....  | 47   |
| Visual Preference Posttest.....   | 50   |
| Manual Preference Test.....   | 50   |
| VI. DISCUSSION.....   | 53   |
| Affective Contingency and Gaze Direction.....                             | 54   |
| Significance.....   | 57   |
| LIST OF REFERENCES.....   | 59   |
| APPENDICES.....   | 68   |
| VITA.....   | 72   |





## CHAPTER I

### INTRODUCTION

Across the first year of life, infants' attention becomes increasingly coordinated between people and objects in their environment (Striano & Rochat, 2000). Although infants engage in social interactions from a very early age, they typically occur in the context of face-to-face dyadic interactions between infant and caregiver. However, between five and twelve months, infants' social-cognitive skills dramatically change from dyadic to triadic interactions involving infant, caregiver, and an object or third person, signaling the emergence of referential looking during this period of life. A fundamental social-cognitive skill known as *social referencing* materializes by the end of the first year. Social referencing is the ability to use others' emotional responses toward unfamiliar objects, people, and events to disambiguate the objects, people, or events referred to (Campos & Sternberg, 1981; Feinman, 1982; Klinnert, 1984). That is, one utilizes others' emotional responses that refer to objects, people, and events to make an appraisal of the situation and gather relevant information about the objects, people, and events being referred to. Social referencing helps infants coordinate their behavior toward people and objects in appropriate ways. For example, a mother and her infant daughter may stroll through their neighborhood when suddenly an unfamiliar dog approaches. The infant typically looks back and forth between the dog and her mother for social/affective cues to guide her actions. Her mother responds with a firm tone and slightly fearful expression. The infant inhibits her reach for the dog. As the example suggests, infants learn to relate others' emotional expressions with objects and events and they either approach or withdraw from the event in accordance with the emotional valence

expressed. Social referencing is an integral part of communication and the development of social cognition.

Research indicates that by approximately one to one-and-a-half years of age, infants reliably use social referencing to regulate their behavior toward people and objects by inhibiting play with novel toys (Gunnar & Stone, 1984; Hornick, Risenhoover, & Gunnar, 1987), by not crossing an apparent (visual) cliff (Sorce, Emde, Campos, & Klinnert, 1985), and by decreasing interaction with a stranger (Boccia & Campos, 1989; Feinman & Lewis, 1983) when adults display expressions of fear or disgust. However, little attention has been devoted to examining how social referencing develops, particularly, what contexts and conditions maximize social referencing in young infants and assessing what are the component skills that underlie this ability.

Social referencing involves several skills including attending to and abstracting emotional information from others, detecting the affective valence of others' expressions, relating others' emotional expressions with objects (or a third person) in the environment, and regulating one's behavior in accordance with others' expressions. A central question is, how and when do infants learn to relate emotional expressions with the objects to which they refer? And what contexts and conditions facilitate successful social referencing in young infants? Two fundamental skills involved in social referencing are the ability to follow head and eye gaze toward the referent object as well as to detect a temporal relationship linking caregivers' expressions and the objects to which they refer (contingency). A temporally contingent relationship refers to the tight timing of a discrete motion/action of an object or third person and the immediate emotional response it elicits

from a caregiver (or experimenter). This tight temporal response is hypothesized to help link or relate emotional expressions with the objects to which they refer.

The purpose of this thesis was to investigate the role of contingency and head and eye gaze direction in infants' perception of affect-object relations. In particular, the study asked, does the contingent relationship between someone's expressions and the objects to which they refer *and* the congruence between someone's gaze and the location of an object influence or facilitate infants' ability to relate the emotional expression with objects and regulate their exploratory behavior toward the objects (i.e., social referencing). One fundamental precursor to social referencing in young infants is the ability to detect and follow another person's eye gaze in order to perceive the relationship between their gaze direction and the object referenced. Following another person's eye gaze allows infants to participate in social interactions, advances communication skills (D'Entremont, Hains, & Muir, 1997) and "governs referential communication between infant and caregiver" (Adamson, 1995). One study assessed infant looking behaviors toward toys gazed at by an experimenter as a function of emotional expression and found that 7-month-old infants looked more to an object that was congruent with the someone's gaze only when a neutral expression was displayed, but not when happy or sad expressions were displayed (Flom & Pick, 2005). Moses and Baldwin (2001) examined whether twelve or eighteen-month-old infants were able to use referential cues including gaze direction toward an object for social referencing, or whether it was only the co-occurrence of affective expressions and the presence of an object that influenced infant social referencing. The results indicated that only 18-month-old infants demonstrated differential exploration of the toys based on the affective expressions paired with each

and demonstrated use of referential cues. However, no studies to date have examined the relative importance of head and eye gaze direction and contingency for social referencing in young infants.

The natural environment typically provides infants with a vast array of stimulation, including people and objects. One basis for relating emotional messages with objects is detection of temporal and spatial contingency between affective expressions and the object to which it refers. Detection of contingencies refers to the ability to perceive and relate a behavior with its consequence. Indeed, caregivers often create such contingencies by responding affectively to an object of interest or concern. For example, a mother may immediately respond with an excited/happy affective expression when a friendly stranger approaches her infant. The present study examines the importance of detecting contingency between the movements of a toy and the affective responses displayed by an actress in five- to six-month-old infants.

Infants are sensitive to contingent relations in face-to-face interactions early in life demonstrating detection of contingencies between two and six months of age (Bigelow & DeCoste, 2003; Bigelow, MacLean, & McDonlad, 1996; Murray & Trevarthen, 1985). Information regarding direction of gaze toward objects in the context of affective expressions is hypothesized to be critical for linking emotional messages with objects in the environment during infancy (see Flom & Pick, 2005; Moses & Baldwin, 2001). Similarly, contingency underscores the relationship between emotional messages and objects in the environment during early infancy. Thus, contingency should provide a basis for the development of social cognitive skills such as joint attention and social

referencing (Gewirtz & Pelaez-Nogueras, 1992; Pelaez, Virues-Ortega, & Gerwitz, in press).

As mentioned earlier, social referencing requires several skills including perception of and discrimination of emotional expressions as well as coordinating attention between another person, an object or event, and the person's emotional responses that refer to the object or event within a social situation. Numerous studies have examined infant perception and understanding of emotional expressions. The following chapter reviews different methods for assessing infant perception of emotions with a particular focus on three methods employed in this dissertation research, infant-controlled habituation, the visual preference method, and the social referencing paradigm.

CHAPTER II  
METHODS AND MEASURES FOR  
EXAMINING INFANT PERCEPTION OF EMOTIONS

Research investigating infant perception and understanding of emotions has used a variety of behavioral methods and measures. They include infant-controlled habituation, the visual preference method, the intermodal matching method, the still face paradigm and other social interaction methods, and the social referencing paradigm. These methods have addressed a variety of skills and capabilities including infant discrimination and recognition of emotional expressions, matching of facial and vocal expressions of emotion, perception of affective valence, perception of the relationship between emotional expressions and objects or events to which they refer, as well as infant regulation of behavior toward objects and events in accordance with another's emotional expressions.

*Infant-Controlled Habituation*

The infant-controlled habituation paradigm has been used to assess infant discrimination and categorization of objects or events (Horowitz, Paden, Bhana, & Self, 1972) including discrimination of emotional expressions (see Walker-Andrews, 1997 for a review). During this procedure, infants are shown a display for a series of trials or presentations for a predetermined amount of time. The trials are infant-controlled because the infants control how long the display is shown on each trial. Typically, the display is withdrawn or turned off (in the case of video displays) immediately after the infant does something such as looking away for a specified period of time such as 1 or 2 seconds. The infants' looking times are recorded for each presentation or trial and as the trials

progress, looking time usually declines. The decline of visual attention to a stimulus across multiple trials is termed *habituation*. Once the infant has habituated or reached a predetermined decrement in looking (e.g. 50%), in relation to the first or first few trials, a novel display (test stimulus) is presented. Visual recovery to the test stimulus, namely an increase in looking to the test stimulus with respect to the previously shown or control stimulus is the dependent measure. Hence, if infants demonstrate visual recovery to the test display(s), then it is concluded that the group of infants has noticed the change or discriminated the display shown during habituation from the test display novel one. Thus, the paradigm allows infants to fully process the stimulus events that are presented to them, in contrast with other looking time methods.

The infant-controlled habituation method can also be used to assess infant categorization and generalization across objects or events (e.g., Bahrick, 2002; Bornstein & Arterberry, 2003; Kestebaum, & Nelson, 1990). In order for infants to categorize a group of objects or events, they must perceive the similarities between discriminably different exemplars within a category and also ignore the differences between those exemplars. For instance, to test infants' ability to categorize the emotional expression of joy, one might habituate infants with different examples of joyful expressions and later present the infants with a new example of a joyful expression and a new category such as a fearful expression. In order to conclude that infants categorize expressions of joy infants must demonstrate greater visual recovery to the new category (fearful expression) than to the new exemplar of the familiar category (a new expression of joy).

The infant-controlled habituation method has been widely used to examine infant discrimination (Barrera & Maurer, 1981; Caron, Caron, & McClean, 1988; Flom &



Bahrnick, 2007; Walker-Andrews & Grolnick, 1983) and generalization of emotional expressions (Bornstein & Arterberry, 2003; Nelson, Morse, & Leavitt, 1979; Walker-Andrews & Lennon, 1991; see Walker-Andrews 1997 for a review of the literature on emotion perception). For example, studies in which infants were habituated to different dynamic facial and vocal expressions indicated that infants could discriminate among expressions of happiness, sadness, and anger by four months of age (Caron, Caron, & McClean, 1988; Flom & Bahrnick, 2007), however, discrimination between those same expressions did not emerge until five months when infants were habituated to vocal expressions (presented with a static face) and did not emerge until seven months of age when infants were habituated to facial expressions alone (with no accompanying vocal information; Flom & Bahrnick, 2007). Furthermore, the findings indicated that temporal synchrony between facial and vocal expressions was necessary for four-month-old infants (but not for older infants) to discriminate between the expressions.

Other studies have also examined the contexts in which discrimination of vocal emotional expressions emerges. For example, Walker-Andrews & Grolnick (1983) found that five-month-old infants habituated to the vocal expressions of happiness and sadness discriminated between the expressions when the vocal expressions were paired with an affectively matching static facial expression. However, three-month-old infants discriminated the expression of sadness from happiness when habituated to a sad vocal expression, but showed no evidence of discrimination if habituated to the expression of happiness and tested with sad vocal expressions. Similarly, Walker-Andrews & Lennon, 1991 found that by five months of age infants discriminated between angry, happy, and sad vocal expressions when presented with a static facial expression but showed no

evidence of discrimination when the vocal expressions were presented with a checkerboard. Thus, these infants required the context of a face to discriminate vocal emotional expressions. The habituation method allows researchers to examine discrimination of emotional expressions under varying conditions and across age.

Habituation studies have also examined infant generalization of affective expressions and found that by four to six months of age infants generalize across different models' static expressions of anger and fear and discriminate among these expressions as well as between anger and surprise and fear and surprise (Serrano, Iglesias, & Loeches, 1992). Another study indicated that by five months of age infants generalize across different models' smiles as well as across different intensities of smiles (Bornstein & Arterberry, 2003). Similarly, Ludemann (1991) assessed whether seven and ten-month-old infants would generalize static expressions sharing the same positive affective valence (happiness and surprise) and discriminate them from negative expressions such as fear and found that only ten-month-old infants demonstrated this ability.

Other infant-controlled habituation studies have investigated the basis for infant discrimination of emotional expressions. For example, researchers asked whether infants use affective valence or a general affective quality vs. feature-specific information to discriminate between different emotional expressions. They have found that by seven months, infants can use affective valence to discriminate between different models' happy expressions versus expressions of fear and anger (Kestenbaum & Nelson, 1990). In their study, infants discriminated the static expressions when faces were presented upright, but not inverted. Face inversion is thought to disrupt affective meaning, however,

feature-specific information is retained. Thus, seven-month-old infants appeared to use affective valence to discriminate among the expressions.

Furthermore, the habituation method can be used to examine detection of relationships between two stimuli (Bahrick, 1992, 1994; Bahrick, Hernandez-Reif, & Flom, 2005; Flom & Johnson, in press; Vaillant-Molina & Bahrick, 2011). For example, researchers have used infant-controlled habituation to present word-object and syllable-object pairings and assessed detection of the relationship by presenting a switch or reversal of the pairings during the test trials (Gogate & Bahrick, 1998; & Werker, Cohen, Loyd, Casasola, & Stager, 1998). The “switch test” displays the same stimulus events presented during the habituation trials, except that the pairing or relationship between stimuli (e.g., syllables and objects) is reversed from habituation to test. A few studies have employed this method to assess detection of relationships between emotional expressions and objects (Flom & Johnson, in press; Vaillant-Molina & Bahrick, 2011). For instance, Vaillant-Molina & Bahrick (2011) habituated five-and-a-half-month-old infants to two films each depicting an affect-object pairing, such as a happy expression paired with a toy robot and a fearful expression paired with a toy pony. During the switch test, the affect-toy pairings were reversed so that the happy expression was paired with the toy pony and the fearful expression was paired with the toy robot. Results indicated that infants habituated to audiovisual events detected the change in affect-object pairings, by showing visual recovery to the switch test. Thus, the paradigm allows one to make inferences about infant discrimination of emotions as well as detection of relationships between emotional expressions and objects and will be used in the present study.

Taken together, the findings from studies that have used the infant-controlled habituation method indicate when and under what conditions discrimination and generalization of several emotional expressions emerges as well as offering insight into infant detection of affective valence and detection of relationships between emotional expressions and objects. The present study uses the infant-controlled habituation method to address the question of under what conditions can infants detect affect-object relations.

### *Visual Preference Methods*

The visual preference method developed by Fantz (1963, 1964) can be used to assess a visual preference for one stimulus over another, discrimination of two stimuli, and memory for a stimulus. Two stimuli are paired side-by-side and infants' looking times to each are measured. Preference for one stimulus or stimulus event over another can be expressed as a proportion by dividing the looking time to one stimulus over the total looking time to both stimuli, or proportion of total looking time (PTLT). If the mean PTLT is significantly greater than 50% across a group of infants, then a preference for one stimulus has been demonstrated and indicates discrimination between the stimuli. The lateral positions of the stimuli are counterbalanced by presenting each stimulus on both the left and right sides during different trials. In addition, some researchers have used sequential presentations of stimuli, rather than paired presentations, and compared looking time to different stimuli in order to assess preferences for one over the other. Order of stimulus presentation is counterbalanced (typically across participants) so that each stimulus is presented first and last.

Researchers have used both paired and sequential visual preference methods to investigate infant discrimination of emotional expressions. For example, LaBarbera, Izard,

Vietze, and Parisi (1976) found that four and six-month-old infants looked significantly longer at pictures of a joyful facial expression than at pictures of an angry or neutral facial expression. Other studies found infant preferences for static images of smiles over frowns and preferences for dynamic (moving) smiles over static pictures of smiles by five months (Wilcox & Clayton, 1968) and preferences for intense smiles over neutral facial expressions emerging as early as three months of age (Kuchuk, Vibbert, & Bornstein, 1986). Thus, studies that use visual preference methods can address questions regarding infant discrimination of and preferences for different emotional expressions. Researchers caution, however, that pairing two different facial expressions (or even sequentially presenting different facial expressions) can result in null preferences because of the relative aversiveness of some expressions (e.g., fear, anger) and that some methods may underestimate infant discrimination of expressions (Schwartz, Izard, & Ansel, 1985). Nevertheless, the visual preference method provides is an effective method for assessing infant visual preferences for stimulus events. The present study uses the visual preference method to address the question of can infants demonstrate visual preferences for objects previously paired with a positive expression as opposed to one paired with a negative expression.

#### *The Intermodal Matching Method*

The intermodal matching method (Bahrick, 1987, 1988; Spelke, 1976) is used to assess whether and on what basis infants can match corresponding information presented across two sense modalities such as vision and audition. Generally, infants view two visual displays accompanied by a single soundtrack located centrally between the visual displays and the soundtrack corresponds to one of the displays. The intermodal matching

method not only allows researchers to assess infant discrimination of stimuli, but also allows assessment of infant matching corresponding information across two sense modalities such as affective valence common across facial and vocal expressions of emotion. Walker (1982; Walker-Andrews, 1986, 1988) tested two to seven-month-old infants using this technique by showing infants two filmed facial affective expressions accompanied by a vocal expression that affectively matched one of the facial displays and found that two-month-old infants looked significantly more to the happy facial expression regardless of which expression the vocal information corresponded with. In contrast, four-month-olds increased looking to the happy facial expression when it was matched by the vocal expression as opposed to when it was mismatched, and five- and seven-month-old infants looked significantly more to all facial expressions (happy, sad, neutral, or angry expressions) when the matching vocal expression was played. Other studies indicate that infant matching of facial and vocal expressions is based on common affective valence rather than temporal synchrony. Infants of seven months of age matched facial and vocal affective expressions even when the expressions were out of synchrony (Soken & Pick, 1992; Walker-Andrews, 1986), when the facial expressions were inverted (upside down; Walker, 1982), and when only motion information was provided by presenting points of light on faces that eliminated any features (Soken & Pick, 1992). Interestingly, two other studies found evidence of infant matching facial and vocal affective expressions that were out of synchrony with each other when the expressions were portrayed by the infants' own mothers and portrayed by other infants rather than adult strangers used in the previously cited studies. These studies reported infant matching emerging by three (Kahana-Kalman & Walker-Andrews, 2001) and five

months of age (Vaillant & Bahrck, 2003). Taken together, the findings from studies that used intermodal matching method arguably provide stronger evidence of infants' perception of emotional valence than the methods described earlier (i.e. habituation; visual preference) because infants must discriminate *and* perceive the temporal and intensity correspondences between stimuli across two sense modalities.

### *The Still Face Paradigm and Other Methods of Social Interaction*

Several researchers have examined infant perception of emotional expressions in the context of a live, face-to-face interaction by using a still face (SF) paradigm. In the SF paradigm, a natural, contingently responsive interaction between caregiver (or experimenter) and infant is disrupted when the caregiver stops the interaction and displays a neutral "still face" (see Muir & Hains, 1993). Researchers measure infant reactions to the still face episode and compare them to their behaviors in the previous episode and a subsequent episode during which natural interactions take place. Other studies have staged social interactions in an effort to examine infant responses to other's emotional expressions in more ecological contexts.

Findings from the SF paradigm indicate that infants are sensitive to responsive affective events from an early age. For example, ten-week-old infants showed differential vocal & facial expressions toward their mother's facial expressions of joy, anger, and sadness in a live interaction and imitated some facial expressions (Haviland & Lelwica, 1987), indicating discrimination among these emotional expressions. Another study found that three-month-old infants smiled more at an unfamiliar adult who interacted with them than at puppets that resembled faces, moved, and made sounds. Further, infants demonstrated more frowns and vocalizations in response to the adult's neutral

expression during the SF episode, but showed no changes in facial or vocal affect when the puppets stopped moving and making sounds (Ellsworth, Muir, & Hains, 1993), indicating discrimination between a live person and a puppet and discrimination among a person's changing affective expressions. Melinder and colleagues (2010) found similar results with infants of two, four, six, and eight months. And although infants at all ages showed more negative affect toward their mother's SF episode than toward a stranger's SF episode, frowns and negative vocalizations in response to the stranger's SF flattened from six to eight months, but decreased toward their mother's SF episode. Thus, the authors concluded that infants are sensitive to other's contingent responsiveness during a social interaction, and that responses to disruptions of contingent responsiveness vary depending on the identity of the person interacting with the infant. Importantly, researchers have examined the effects of another sense modality, touch, on infant responses during face-to-face interactions. Findings from the studies indicate that one-and-a-half to three-month-old infants made more eye contact, smiled more, produced more vocalizations, and cried less during face-to-face interactions that included an experimenter touching the infants' legs than interactions that did not include touching (Pelaez-Nogueras, Gewirtz, Field, Cigales, Malphurs, Clasky, & Sanchez, 1996) and that touch provided during a SF episode led to greater frequency of smiling and less frequency of crying in infants of depressed mothers than infants of non-depressed mothers (Pelaez-Nogueras, Field, Hossain, & Pickens, 1996). Thus, very young infants are sensitive to tactile stimulation in the context of face-to-face interactions and tactile stimulation may moderate the effects of neutral and non-responsive expression during the SF episode.



In order to examine infant responses to emotional expressions in more ecological and naturalistic contexts than typically employed using habituation and visual preferences methods, Montague and Walker-Andrews (2001) used a modified peek-a-boo game in which the typical happy and surprised expression was varied and depicted anger, fear, and sadness. Four-month-old infants responded with a different pattern of looking and affective expression to each of the expressions displayed. The findings indicated that infants discriminated and responded to the different expressions in a meaningful way. For example, they showed more looking to expressions of fear and anger relative to sad and typical happy/surprise and more smiling and vocalizing to happy/surprise relative to other expressions. Together, the findings suggest that infants are sensitive to contingency in face-to-face interactions and to different emotional expressions conveyed in the context of social interactions within the first half year of life.

### *The Social Referencing Paradigm*

In order to explore infants' ability to use others' emotional expressions as information about objects and events in the environment, researchers have used the social referencing paradigm (Feinman, 1982; Feinman & Lewis, 1983; Klinnert, 1984; Klinnert, Emde, Butterfield, & Campos, 1986). The paradigm typically involves staging an ambiguous situation or presenting novel objects (or a stranger) to infants, asking the infants' mothers (or an experimenter) to respond to the situation or object with a particular emotional expression, and observing infants' reactions to the situation or object. Essentially, the infant is expected to relate the mother's (or experimenter's) emotional response with the target object or event and to regulate their actions toward the object or event in accordance with the emotional expression displayed by the mother. The

paradigm provides evidence for a social-cognitive skill known as social referencing, or the ability to use another's affective responses to objects, people, and events to disambiguate or guide one's own appraisal of the object or event (Feinman, 1982; Sorce, Emde, Campos, & Klinnert, 1985). For example, an infant would be expected to inhibit touching or playing with an ambiguous toy that elicited a fearful expression from the infant's caregiver. Researchers have used toys, strangers, animals, and a visual (apparent) cliff as ambiguous objects and events (Camras & Sachs, 1991; Feinman, 1982, 1983; Gibson, 1969; Gunnar & Stone, 1984; Hornik & Gunnar, 1988; Klinnert, 1984; Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme & Fernald, 2003; Mumme, Fernald, & Herrera, 1996; Sorce, Emde, Campos, & Klinnert, 1985; Vaish & Striano, 2004). Typically, infants successfully demonstrate the ability to reference another's emotional expression to guide their own behavior by twelve months of age (Feinman & Lewis, 1983; Hertenstein & Campos, 2004; Hornick, Risenhoover, & Gunnar, 1987; Mumme & Fernald, 2003; Vaish & Striano, 2004; Walden & Ogan, 1988), although a few studies suggest this ability may emerge as early as four to ten months of age in certain contexts (Pelaez, Virues-Ortega, & Gewirtz, in press; Vaillant-Molina & Bahrnick, 2011; Walden & Ogan, 1988). For example, when several measures have been used to examine differential behaviors toward toys paired with positive and negative affective expressions such as latency to touch, time spent touching toy, and looking toward parent during and after emotional expressions were displayed, young infants have shown evidence of social referencing (Walden & Ogan, 1988). Importantly, Pelaez, Virues-Ortega, and Gewirtz (in press) showed that four to five-month-old infants could be trained, via operant conditioning, that reaching toward a toy after a positive expression was portrayed in

response to the toy lead to a positive stimulus, namely presentation of soft music and colored lights. Learning of the consequence was indexed by increases in infant reaching behavior toward the toy relative to baseline trials. Conversely, infant reaching of another toy after a negative expression was displayed toward the toy lead to a negative consequence, a noisy blender and blue lights. Detection of the consequence was indexed by a decrease in infant reaching behavior relative to baseline. Thus, four to five-month-old infants learned that positive expressions portrayed just prior to the infants' reaches lead to positive consequences and negative expressions portrayed prior to reaching lead to negative consequences. The consequences either reinforced or diminished reaching behavior in accordance with affective valence of the expressions (positive vs. negative) and negative or positive stimuli presentations (aversive vs. not aversive). The study suggests that social referencing may be learned from experience with positive and negative consequences for the infant in daily social interactions involving objects and events.

Another foundational study examined the contexts that maximize social referencing in young infants by comparing infant touches to novel objects previously paired with positive or negative expressions in dynamic audiovisual or visual only presentations (Vaillant-Molina & Bahrick, 2011). Findings demonstrated that five to six-month-old infants learned to relate a happy expression with one novel moving toy and a fearful expression with another novel moving toy and significantly preferred to touch the toy that had been paired with the happy expression over the toy that had been paired with the fearful expression displayed in the audiovisual presentations (evidence of social referencing), but showed no touching preferences for either toy in the visual only

presentations. Hence, dynamic, audiovisual presentations promoted young infants' detection of the relationship between expressions and toys and promoted an early form of social referencing. Furthermore, the happy and fearful expressions were contingently displayed upon the movements of the novel toys, such that every time the toys moved, the actress responded immediately with an emotional expression, and the expressions were displayed only after movements of the toys. The actress's eye and head gaze direction was also congruent with the location of the toys. While contingency between the affective expressions and toys' movements and gaze information were not directly tested, they were present in both the audiovisual and visual only conditions suggesting their important role for the emergence of social referencing.

Social referencing has been viewed as a social-cognitive skill that requires coordination of attention to people, objects, and events including detection of another person and of another's emotional expressions, detection of objects or events in the surrounding environment, detection of the relationship between another's emotional expressions and the objects or events to which the expressions refer, and use of such affective referential information to guide one's interpretation or appraisal of the object or situation (see Vaillant-Molina & Bahrack, 2011 for discussion). Some researchers propose that social referencing constitutes both active seeking of and passive use of affective information (Feinman, 1982) while others limit social referencing to active seeking of emotional information in situations of uncertainty or ambiguity (Campos, 1983). Others have argued that social referencing may constitute a more general learning process, not specific to emotions or affective information (Gewirtz & Pelaez-Nogueras, 1992). Regardless of definition, investigation of when and how infants learn about

objects and events from social interactions involving affective expressions and use such affective information to guide their own actions would contribute to our understanding of social-cognitive development. Indeed, important questions remain regarding when and under what conditions infants can detect relations between other's emotional expressions and objects and use such affective information to guide their own actions in relevant and adaptive ways. Hence, the purpose of this thesis is to shed light on which contexts and variables are fundamental to perception of affect-object relations and subsequent actions based on affect-object relations. The present study uses a modified social referencing paradigm to address the question of under what conditions can infants use affect-object relations to guide their manual exploration of objects. Studies that have addressed similar and related questions regarding the phenomenon and development of social referencing will be reviewed in a subsequent chapter.

In summary, several methods and measures of infant perception including infant-controlled habituation and visual preference methods have been used to assess detection of, discrimination, generalization of, and preferences for affective expressions. The intermodal matching method and several other paradigms that involve infant reactions to social interactions have also been used in an effort to address when and how infant perception of affective valence emerges and develops. And finally, the social referencing paradigm has been used to examine infant detection of the relationship between another's affective expressions and objects or events to which the expressions refer (affect-object and affect-event relations) and the subsequent use of affective referential information to guide infants' own actions toward objects or events in accordance with the affective

valence displayed. Studies employing these methods indicate an array of infant perception and understanding of emotions by the end of the first year of life.

The study was designed to employ a unique combination of several methods reviewed, the infant-controlled habituation paradigm, the visual preference method, and a modified social referencing paradigm in a single study. The combination provides a more powerful way of addressing the question of under what conditions can infants use information about affect-object relations to guide exploratory behavior. Infant-controlled habituation allows infants to process the events until they are habituated. Conditions of habituation can be easily manipulated and a switch test can reveal infant detection of a change in affect-object relations. Then, a live preference test for the 3-dimensional objects can reveal the conditions under which affective information guided exploratory behavior. The following chapter presents research on infant development of component skills thought to be necessary for perception of and understanding of affect-object relations and the emergence of social referencing.

## CHAPTER III

### LITERATURE REVIEW

Infants experience others' emotional expressions from early in life beginning in dyadic interactions which primarily characterize infants' social repertoires during the first months of life. Around four to five months of age, infants' attention is increasingly drawn to objects outside of the dyadic interaction. Caregivers show infants objects and communicate with them in the context of triadic interactions. By at least nine months of age, infants start to follow other's gaze in relation to objects and other people in their surrounding environment (Carpenter, Nagell, & Tomasello, 1998). Infants also engage in joint visual attention in order to share attention with another person about an object or third person of mutual interest (Bakeman & Adamson, 1984; Carpenter et al., 1998; Corkum & Moore, 1998). Joint attention provides shared experiences needed for social development and learning, including language development (Baldwin, 1995; Dunham & Moore, 1995; Morales, Mundy, & Rojas, 1998; Tomasello, 1995). As discussed in the previous chapter, social referencing entails sharing visual attention with another person about an object, person, or event, linking emotional information that refers to the object, person, or event, and using the emotional information to guide one's actions toward the object, person, or event in accordance with referential emotional information. Thus, following another person's gaze as well as joint visual attention to an object or person are necessary components of social referencing. As a result, a developmental trajectory of when and under what conditions gaze following and joint attention abilities emerge and develop is important for understanding the emergence and development of social referencing.

### *Gaze following and Joint Visual Attention*

Infants as young as three to five months of age are sensitive to another person's direction of gaze. For example, Striano and Stahl (2005) showed that three-month-old infants smiled and gazed more at an experimenter when the experimenter coordinated attention between an object and the infant than when the experimenter only attended to the object. Thus, infants as young as three months were able to discriminate a triadic from a non-triadic context using an adult's direction and coordination of eye gaze. And Hood, Willen, and Driver (1998) found that three-month-old infants looked more frequently and more rapidly to a target object that corresponded with an adult's direction of gaze than to an object that did not correspond to direction of gaze. Indeed, infants have been shown to engage in a variety of social cognitive tasks including coordinating attention with another person, gaze following, and point following by the first half year of life (D'Entremont, 2000; Striano & Bertin, 2005a, 2005b). And by seven to twelve months of age infants' joint attention skills improve as attention becomes more coordinated with others in relation to objects and events in the environment (Butterworth, 1995; Carpenter et al., 1998).

Several researchers have examined relations among gaze following and joint attention skills and other social, communicative, and cognitive skills. For example, infants' ability to follow another person's gaze at six months of age was found to be positively correlated with emotion regulation at 24 months (Morales, Mundy, Crowson, Neal, & Delgado, 2005), and joint engagement and gaze following were found to be positively correlated with production of words by infants of 12 to 15 months (Carpenter et al., 1998). Similarly, Slaughter and McConnell (2003) found positive correlations



between gaze following and the number of words produced by infants of eight to fourteen months, but found no correlations among gaze following, imitation, and social referencing. However, Striano, Stahl, and Cleaveland (2007) found relationships among coordinating visual attention with someone toward an object and smiling in the context of coordinating visual attention, and relationships among gaze following and imitation, but found no correlations among other joint attention behaviors in a longitudinal study of infants seven to ten months of age. Furthermore, gaze following and other joint attention behaviors (e.g., smiling while coordinating attention with someone) emerged earlier than imitation. The authors concluded that joint attention behaviors develop in a complex way and more research is needed to understand how different social-cognitive skills emerge and change throughout infancy and childhood.

The ability to follow another's direction of gaze and the ability to share attention with another person about an object or third person are thought to be fundamental skills for the development of social referencing. Following another's direction of gaze promotes attention to relevant aspects of the environment and promotes the coordination of attention between a caregiver, the infant, and an object of interest. From this perspective, investigation of the development of component skills is warranted. A prior study indicated that social referencing emerged in the context of intersensory redundancy provided by audiovisual events (Vaillant-Molina & Bahrick, 2011). Thus, intersensory perception was found to be a fundamental skill for early social referencing. Another factor that may contribute to the emergence of social referencing is gaze congruence with the object eliciting someone's emotional expressions. A third factor that may contribute to the emergence of social referencing is contingency perception. In particular,

contingency between the motion of objects and the emotional expressions the objects elicit may provide crucial information for infant detection of affect-object relations that guide infant exploratory behavior in accordance with the affective expressions. The following section reviews research on infant perception of contingencies.

### *Contingency Detection*

Contingencies provide highly salient information about the temporal, spatial, and causal relationships between events (Tarabulsky, Tessier, & Kappas, 1996). When an action is perfectly contingent upon another action, a perfect correspondence exists such that the occurrence of action B always follows action A and action A always precedes the occurrence of action B. Young infants are sensitive to contingent relations present in the environment and in the context of social interactions from an early age (Harrist & Waugh, 2002; Tarabulsky, Tessier, & Kappas, 1996) and detection of contingencies are thought to promote the development of social cognition (Rochat & Striano, 1999). For example, three to five-month-old infants detect the temporal and spatial contingency between the visual information provided by live video feedback of their own legs and arms moving and the proprioceptive information corresponding to those movements (Bahrick & Watson, 1985; Rochat & Morgan, 1995; Schmuckler, 1996). Infants use this contingent information to discriminate a live video of their leg movements (self) from a pre-recorded video of their leg movements or a video of another infant's leg movements (other; Bahrick & Watson, 1985). Studies on contingency learning using infants' own actions indicate that infants learn to kick a mobile in order to produce movement by three months of age, and that infants can remember the contingency between their behavior and

the movement of a mobile over a period of days (Hayne, Gross, Julien, Hidreth, & Rovee-Collier, 2000; Hayne, Greco-Vigorito, & Rovee-Collier, 1993).

Young infants are also sensitive to social contingencies during face-to-face interactions. They demonstrate greater visual attention, length of look, and more smiles toward a live video of their mothers interacting with them as compared to a replay video (Bigelow, MacLean, & McDonald, 1996; Hains & Muir, 1996) and prefer contingent over noncontingent social responses (Murray & Trevarthen, 1985). Within the context of a social interaction, young infants are sensitive to their caregivers' adjustment of facial, vocal, and tactile stimulation including affective expressions in response to infant behavior, often termed attunement (Field, Healy, Goldstein, & Guthertz, 1990; Stern, Hofer, Heft, & Dore, 1985). Thus, infants discriminate between responsive and unresponsive stimulation within the context of face-to-face interactions within the first months of life. Contingency serves as a basis for linking events in the environment and provides information about how events are related to one another. Detecting contingencies between events is critical to predicting events, interacting, and behaving in appropriate ways (Tarabulsky, Tessier, & Kappas, 1996). Thus, in early development, sensitivity to contingent relations between affective expressions and objects to which they refer might help infants link emotional signals and objects or events in the context of social referencing. The proposed study will test this prediction.

### *Social Referencing*

Research on social referencing suggests that somewhere between 12 and 18 months of age, infants can use other's affective expressions to regulate their behavior toward novel objects or ambiguous situations in accordance with the expressions of the emoter

(Boccia & Campos, 1989; Campos & Sternberg, 1981; Feinman and Lewis, 1983; Hertenstein & Campos, 2004; Kim, Walden, & Knieps, 2010; Klinnert, 1984; Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme & Fernald, 2003; Sorce, Emde, Campos, & Klinnert, 1985; Vaish & Striano, 2004; Walden & Baxter, 1989; Zaratany & Lamb, 1985). For example, Sorce and colleagues (1985) found that one-year-old infants were more likely to cross a visual cliff after their mothers portrayed happy expressions, than when they displayed fearful expressions. A few studies have tested younger infants. However, these studies have yielded mixed results with two studies finding evidence of social referencing as young as four to five (when infants were trained via operant conditioning; Pelaez, et al., in press) and eight-and-a-half months (Boccia & Campos, 1989) and other studies not finding evidence of social referencing until after nine to ten months (Mumme & Fernald, 2003; Walden & Ogan, 1988). Typically, by 12 months of age infants are able to link specific objects or events with another person's emotional messages (Hertenstein & Campos, 2004; Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme & Fernald, 2003) and actively seek out emotional information from others to guide their actions toward those objects and events in meaningful ways (Campos & Sternberg, 1981; Feinamn, 1982). Furthermore, by 16 months of age infants respond differently to objects referenced with emotional expressions of a similar (fearful vs. sad) valence, indicating further refinement of social cognitive competencies (Martin, Witherington, & Edwards, 2008). However, few studies have examined how context or type of stimulation influences infants' ability to successfully perform a social referencing task, particularly in early infancy.

One study explored young infants' social referencing skills and demonstrated that by four to five months, infants learned (via operant conditioning) that reaching for a novel object after their mother's displayed a happy facial expression lead to positive consequences (soft music, colorful lights) and that reaching for a novel object after their mother's displayed a fearful expression lead to negative consequences (loud noises made by a blender, buzzer, and whistle) by differentially reaching toward the objects as a function of the facial expressions. Thus, infants reached more frequently after viewing their mothers' happy expressions than after viewing their mother's fearful expression indicating that social referencing can be learned through environmental contingencies by four months of age, much younger than the social referencing literature suggests (Pelaez et al., in press). Still, it is important to study what components are necessary and sufficient for infants' ability to detect relationships between affective expressions and objects to which the expressions refer as well as for guiding infant behavior toward objects or events in accordance with the emotional information displayed. One potentially fundamental component is the type of stimulation that is presented in affective expressions.

The few studies that have looked at differences in infant social referencing across varying types of stimulation find that by one year of age infants use affective information from others to promote or inhibit either crossing a visual cliff or manually exploring novel toys when both facial and vocal expressions are used (Vaish & Striano, 2004) and when vocal only expressions (no facial expression) are provided (Mumme, Fernald, & Herrera, 1996; Vaish & Striano, 2004). Thus, by the end of the first year of life, infants use both audiovisual and auditory only information to gather information about another

person's affective responses to an ambiguous situation and either approach or withdraw in accordance with the affective information. However, there have been no systematic examinations of how different types of stimulation facilitate young infants' ability to relate affective information to objects in the environment and guide their behavior accordingly. Indeed, types of stimulation often influence what kinds of information infants selectively attend to at the expense of others and provides a mechanism for guiding and constraining attention to particular stimulus properties of events. One such mechanism is proposed by the Intersensory Redundancy Hypothesis (IRH) and is potentially useful for understanding how infants' attention is allocated to perceptual properties in social affective events.

#### *Intersensory Redundancy and Attention to Stimulus Properties*

The IRH is a theory of selective attention and proposes that multimodal (i.e., audiovisual) redundant stimulation selectively guides attention to amodal information (e.g., tempo, intensity, affect) at the expense of modality-specific information (e.g., color, visual pattern; Bahrick & Lickliter, 2000, 2002). Research on infants' attention to different stimulus properties in different types of stimulation has provided support for this hypothesis and demonstrated that amodal information such as rhythm, tempo, and affect are perceived first in multimodal (i.e., audiovisual) stimulation and later in unimodal stimulation (Bahrick, Flom, & Lickliter, 2002; Bahrick & Lickliter, 2004; Flom & Bahrick, 2007). A type of "intersensory facilitation" has been observed in both human infants (Bahrick, Flom, & Lickliter, 2002; Bahrick & Lickliter, 2004) as well as in an avian species (bowwhite quail; Lickliter, Bahrick, & Honeycutt, 2002) suggesting that similar principles guide attention across different species. Moreover, findings regarding

infants' perception of affective expressions indicate that infants first discriminate one emotional expression from another in audiovisual stimulation (bimodal) by four months of age, then later in development, by five months, they discriminate affect in unimodal vocal only stimulation, and last, by seven months, they discriminate affective expressions from one another in unimodal visual stimulation (Flom & Bahrick, 2007; see Walker-Andrews, 1997). Thus, redundant facial and vocal information such as the temporal and rhythmic patterns displayed in affective expressions appears to be highly salient for young infants and provides a context in which discrimination and recognition of affective expressions emerges during early infancy.

Building on this, Vaillant-Molina and Bahrick (2011) tested five-and-a-half-month-old infants in a modified social referencing task under audiovisual redundant (bimodal) or visual only non-redundant (unimodal) stimulation. Infants' ability to detect the relationship between a toy and an actress's emotional responses and subsequent exploration of the toys was assessed. Infants viewed films of a toy moving across a table and an actress responding affectively with either a happy or fearful expression in bimodal audiovisual or unimodal visual conditions. Infants in the bimodal audiovisual condition detected a change in the affect-toy pairing during a switch test and subsequently showed touching preferences for the toy paired with the happy expression. However, infants in the unimodal visual condition did not show evidence of detecting the affect-toy pairing and showed no differential touching to the toys. Thus, the findings of the study indicate that young infants' social referencing skills emerge in the context of naturalistic audiovisual redundant stimulation provided by congruent facial and vocal affective expressions. Furthermore, the study depicted a naturalistic contingent relation between

movements of the toys and the actress's affective expressions (the actress responded affectively to each movement). The actress also displayed naturalistic head and eye gaze following of the toy's movements in order to provide young infants with a basis for relating the affective expressions and the toys. However, the importance of these variables was not directly tested and thus is not currently known.

#### *Test of the Role of Contingency and Gaze Direction*

The study built upon a prior study that explored the topic (Vaillant-Molina & Bahrick, 2011). It directly assessed the extent to which contingency between toys' movements and the actress's affective expressions and congruent head and eye gaze toward the toys contribute to infants' ability to relate affective expressions with novel toys. The previous study examined the role of multisensory stimulation in young infants' ability to relate affective expressions with objects and infants' subsequent actions toward those objects by presenting unimodal visual vs. bimodal audiovisual events. Results indicated that audiovisual information was required. The current study built upon these findings by presenting dynamic audiovisual filmed events and examining the contribution of two other factors, contingent relations between affective expressions and object movement as well as the contribution of congruent (with toy location) head and eye gaze direction in young infants' detection of affect-object relations and their subsequent manual exploration of the objects.

Infants were habituated to two alternating films depicting toys moving across a surface while an actress says "oh it moves, look it moves." One toy was paired with the actress' happy expression and the other toy with the actress' fearful expression. The study was designed as a 2 x 2 (contingency: contingent affect, noncontingent affect) (gaze



direction: congruent gaze with toy's location, incongruent gaze with toy's location) experiment with a total of 4 conditions. The Contingent Affect and Congruent Gaze condition depicted contingency between the actress' affective expressions and the toys' movements *and* congruence between the actress' head and eye gaze direction and the toys' location . The Contingent Affect and Incongruent Gaze condition depicted affective contingency with the toys' movements *and* a lack of gaze congruence with the toys' location. The Noncontingent Affect and Congruent Gaze condition condition depicted no affective contingency *and* depicted gaze congruence. Finally, Noncontingent Affect and Incongruent Gaze condition depicted no affective contingency *and* depicted no gaze congruence.

Infants' detection of the relationship between the toys and the affective expressions was assessed in a switch test during which the pairing of the affective expressions and the toys (affect-object relations) was reversed. For example, if an infant was habituated to happy affect paired with toy A and fearful affect paired with toy B, then the infant was tested with happy affect paired with toy B and fearful affect paired with toy A. Subsequently, infants' reaching and touching preferences for toys previously paired with the happy vs. the fearful expressions was tested. It was predicted that both contingency between the toys' movements and an actress's affective expressions and gaze direction toward the toys' locations would be necessary for young infants' detection of affect-object relations. Thus, a main effect of contingency and a main effect of gaze direction for visual recovery to a change in affect-object pairing was predicted. Contingency was hypothesized to be a key factor in infants' early social referencing skills, thus a main effect of contingency for proportion of the total number of touches and proportion of total

time spent touching the toy previously paired with the positive expression was also predicted. Gaze direction was also hypothesized to be an important factor for young infants' detection of affect-object relations and early social referencing skills.

Alternatively, results may have demonstrate that contingency was important for infants' perception of affect-object relations and social referencing, while gaze direction was not. Thus, a main effect of contingency would have been found, with no main effect of gaze direction. Indeed, contingency detection develops prior to gaze following skills (some prenatal experience with proprioceptive contingency is likely), and thus may not be necessary for social referencing at the age infants were tested (five to six months). Finally, infants in the Contingent Affect & Congruent Gaze condition were predicted to detect the affect-object relations and subsequently show manual preferences for the object paired with the positive expression if contingency and gaze direction play an important role in the development of social referencing. It was also predicted that infants in the Noncontingent Affect & Incongruent condition would not show evidence of detection of the affect-object relations and would not show manual preferences for the object paired with the positive expression in a subsequent manual preference test since at least one factor, contingency, and likely both factors (contingency and gaze direction) would be necessary for young infants' detection of affect-object relations and social referencing.

### *Hypotheses and Predictions*

Infants were not expected to show overall baseline preferences for either toy prior to viewing the habituation filmed events. Thus, it was predicted that infants should not demonstrate a significant proportion of total looking time (PTLT) to either toy during the

visual preference pretest. To examine the role of affective contingency and gaze direction, 2 x 2 affective contingency (present vs. absent) and gaze direction (congruent vs. incongruent) between-subjects design was used with a total of four conditions. The contingent relations between the toys' movements and the actress' affective expressions *and* the congruence between the direction of head and eye gaze and the toy's location varied across conditions in order to directly test the role of these variables in infants' ability to relate objects and affective expressions as well as their role in infants' ability to subsequently show manual preferences for the objects. Below are specific research questions, hypotheses, and predictions for each habituation condition.

1) Contingent Affect and Congruent Gaze condition: Will five- to six-month-old infants detect the relationship between an actress's affective expressions and moving toys when there is affective contingency between the movements of toys and the expressions of an actress and when there is head and eye gaze congruence with the toy's location? Will infants show visual and manual preferences for the toy paired with the happy expression during the visual preference posttest and manual preference test? If either contingency or gaze direction or both variables are important for infants' detection of affect-object relations, then infants should demonstrate significant visual recovery to a change in affect-object pairings during the switch test. Furthermore, if contingency or gaze direction or both are important for guiding infants' visual preferences and exploratory behavior, then infants should demonstrate significant PTLT to the toy paired with the happy expression during the visual preference posttest and should demonstrate significant proportion of total number of touches (PTNT)

and/or proportion of total time spent touching (PTTT) the toy paired with the happy expression during the manual preference test.

Additionally, if both contingency and gaze direction are important for detection of affect-object relations, then a main effect of both contingency and gaze direction for visual recovery to a change in affect-object pairings as well as an interaction between these variables would have been expected, with greater visual recovery scores for infants in the contingent affect and congruent gaze condition than infants in the noncontingent affect and incongruent gaze condition, and possibly greater visual recovery scores for infants in the contingent affect and congruent gaze condition than all other conditions.

Given that contingency perception is evident very early in life, and gaze following does not emerge until several months later, it is possible that at five- to six-months of age contingency between affective expressions and toys' movements provides enough information for relating expressions and objects, while gaze direction may not be necessary to link expressions and objects. If so, then a main effect of contingency for visual recovery to a change in affect-object pairings would demonstrate that infants in the contingent affect conditions (regardless of whether gaze direction was congruent or incongruent with toy's location) learned to relate affective expressions with moving toys. Similarly, a main effect of contingency for PTLT to the toy paired with the happy expression during the visual preference posttest and PTNT and/or PTTT to the toy paired with the happy expression during the manual preference test would demonstrate that infants in both contingent affect conditions (congruent gaze and incongruent gaze) preferentially looked at and touched the toy that had been previously paired with the happy expression.

- 2) Contingent Affect and Incongruent Gaze condition: Will five- to six-month-old infants detect the relationship between an actress's affective expressions and moving toys when there is affective contingency between the movements of toys and the expressions of an actress and when there is no congruence between head and eye gaze and the toy's location? Will infants show visual and manual preferences for the toy paired with the happy expression during the visual preference posttest and manual preference test? If so, then infants in the contingent affect and incongruent gaze condition should demonstrate significant visual recovery to a change in affect-object pairings indicating that affective contingency was sufficient for infants' ability to relate affective expressions and objects to which they refer. Infants would also demonstrate significant PTLT, PTNT, and PTTT to the toy previously paired with the happy expression, indicating that contingency was sufficient to guide infants' looking and touching preferences for toys paired with the positive expression. However, if both contingency and gaze direction are necessary for young infants' detection of affect-object relations and necessary for guiding infants' looking and manual preferences, then infants in the contingent affect and incongruent gaze condition should not show significant visual recovery to a change in affect-object pairings, and should not show significant PTLT, PTNT, and PTTT to the toy that had previously been paired with the happy expression.
- 3) Noncontingent Affect and Congruent Gaze condition: Will five- to six-month-old infants detect the relationship between an actress's affective expressions and moving

toys when there is no contingency between the movements of toys and the expressions of an actress and when there is congruence between head and eye gaze and the toy's location? Will infants show visual and manual preferences for the toy paired with the happy expression during the visual preference posttest and manual preference test? If so, then gaze direction would be sufficient for detection of affect-object relations in young infants. Furthermore, gaze direction would be sufficient to guide visual and manual preferences for toys previously paired with a happy expression.

4) Noncontingent Affect and Incongruent Gaze condition: Will five- to six-month-old infants detect the relationship between an actress's affective expressions and moving toys when there is no affective contingency between the movements of toys and the expressions of an actress and when there is no congruence between head and eye gaze and the toy's location? Will infants show visual and manual preferences for the toy paired with the happy expression during the visual preference posttest and manual preference test? If so, then detection of affect-object relations would be based only on the co-occurrence of the affective expressions and the toys. Similarly, if infants show significant PTLT, PTNT, and PTTT to the toy previously paired with the happy expression, then it would indicate that an early form of social referencing was based solely on the co-occurrence of emotional expressions and toys.

Both contingency and gaze direction were hypothesized to play an important role in the detection of affect-object relations and in visual and manual preferences for toys paired with a positive expression. Thus, a main effect of affective contingency (present

vs. absent) and a main effect of gaze direction (congruent gaze vs. incongruent gaze) for infants' visual recovery to a change in affect-object relations were predicted.

Furthermore, an interaction effect for each dependent measure was also thought to be a possible finding, given that affective contingency was predicted to influence infants' detection of affect-object relations and influence their preferences for objects paired with the positive expression when gaze direction was congruent with the toys' location.

Likewise, gaze direction was thought to influence infants' detection of affect-object relations and subsequent preferences for objects referenced with a positive expression when affective contingency was present. Finally, contingency between affective expressions and toys' movements as well as congruence between head and eye gaze and toys' location were predicted to be important variables for an early form of social referencing.

## CHAPTER IV

### METHOD

#### *Participants*

Sixty-four five- to six-month-old infants (34 males and 33 females) with a mean age of 170 days ( $SD= 15$ ) participated in the study. All infants had a gestational age of at least 38 weeks and Apgar scores of at least nine (out of ten). Fifty infants were Hispanic, nine were Caucasian, three were African American, and two were Asian. Nineteen additional infants participated but their data were excluded as a result of excessive fussiness ( $N=4$ ), experimenter error ( $N=3$ ), failure to meet the fatigue criterion ( $N=2$ ), failure to habituate within 20 trials ( $N=9$ ), and interference during the manual preference test ( $N=1$ ; parent touched one of the toys presented). Infants were recruited from county birth records provided by the Vital Statistics office. Parents were contacted by telephone and mailed letters inviting them to participate in the study with their infants. All parents were offered a gift in the amount of \$10.00 for their participation in the study.

#### *Stimuli*

Four filmed events were used for the habituation phase of the study. One film consisted of a moving toy bunny eliciting an actress' happy/excited emotional expression, and another film depicted the toy bunny eliciting a fearful expression. A third film depicted a toy robot eliciting the actress' happy/excited expression and a fourth film depicted the robot eliciting the actress' fearful expression. Each film consisted of 60-s clips that looped, and each clip depicted an average of seven (range: six to eight) toy



movements and seven affective expressions. The toy robot moved forward and backward on a table while opening its arms making a clicking sound. The bunny moved forward while intermittently raising its ears, making snorting sounds. The actress depicted either a happy/excited or fearful/disgust expression while saying, “Oh it moves. Look it moved!” (same as in Vaillant-Molina & Bahrick, 2011). Each of the films were displayed under four conditions (contingent affect & congruent gaze, contingent affect & incongruent gaze, noncontingent affect & congruent gaze, and noncontingent affect & incongruent gaze) that manipulated two independent variables, affective contingency and gaze congruence for a total of 16 filmed events. The major difference between stimuli in the contingent and noncontingent affect conditions was that the contingent affect condition depicted the movements of the toy eliciting the actress’ affective expressions, whereas the noncontingent affect conditions did not. The contingent affect conditions displayed the actress responding with an affective expression immediately after (with an average delay of 0.5 seconds from toys’ first movement) every movement of the toys and only responded when the toys moved. Thus, the contingent conditions displayed a predictable, temporal relationship between the start of the toy’s movements and the actress’s affective response. The noncontingent conditions depicted the toys’ movements and the affective expressions in a random temporal pattern, with no systematic relation to one another. Thus, the actress’s affective expressions sometimes occurred prior to the toy’s movements and sometimes occurred after the toy stopped moving. There was an average delay of five seconds (range of four to six seconds) between last movement of the toys

and the actress's expressions (and between end of expressions and first movement of the toys). The same number of movements and affective expressions were displayed by the actress for contingent and noncontingent affect conditions.

The congruent and incongruent gaze conditions displayed the actress's head and eye gaze direction either congruent with or incongruent with the location of the toy's movements. In the congruent gaze condition, the actress's head and eye gaze followed the toy as it moved across the table. In the incongruent gaze condition, the actress's head and eye gaze appeared to track an imaginary object moving in a different direction from the actual toy. Frequency of head and eye movements and frequency of back and forth looks between the toy and camera were equated across all conditions. Other than the congruence between head and eye gaze and the toys' location, all other aspects of the stimulus films were comparable across conditions.

The affect-object pairings and order of presentation of the filmed events were counterbalanced across infants. Only the surface of the table, the toys, and the actress were visible in the films to maximize infants' attention to the event rather than to background objects (same as in Vaillant-Molina & Bahrick, 2011). The bunny and robot toys were of similar size (7 x 5.9 inches and 4.8 x 5.8 inches, respectively) but differed in shape, color, and pattern. The actual 3-dimensional toys were also presented during a visual preference pretest and posttest and during the manual preference test.

### *Apparatus*

Infants were seated in an infant seat on top of a table facing two 19-inch computer monitors (Dell Precision T3400), approximately 55 cm away. The monitors were surrounded by black poster board and two apertures above the monitors allowed observers to record the infants' visual fixations. Trained observers unaware of the infant's condition and unable to see the displays on the monitor recorded infants' visual fixations by pressing and holding down a button on a joy stick while the infant fixated on the stimulus presentation. The joy stick was connected to a computer that recorded and computed the duration of the visual fixations to the displays and signaled another experimenter as to when to commence and terminate each trial. A record of each infant's visual fixations was created on-line and saved for subsequent analysis. Inter-observer reliability was obtained for 25% of the participants. Infants' manual exploration of the toys was recorded (Cannon Optura 60 camcorder) for later analysis.

### *Procedure*

Infants participated in an initial visual preference pretest during which the 3-dimensional toys (bunny and robot) were presented on a tray out of arms reach in front of the infants. After the pretest, infants participated in an infant-controlled habituation and switch test phase under one of four conditions previously described (contingent affect & congruent gaze, contingent affect & incongruent gaze, noncontingent affect & congruent gaze, and noncontingent affect & incongruent gaze). Infants then participated in a visual preference posttest and finally a manual preference test (see Table 1 for details).

*Visual Preference Pretest.* Infants were seated on a table and held by an experimenter (blind to the hypotheses of the study) during the visual preference pretest. A second experimenter, on the right side of the infant, placed the bunny and robot toys side by side on a tray covered with a black cloth. Then, the infant was turned to face the covered toys positioned in front of them and out of reach, the experimenter uncovered the toys, walked behind the infant, and two 10-s trials began. When the first trial ended, the experimenter covered the toys with the black cloth for a few seconds, switched the lateral position of the toys, uncovered the toys and the second trial began. The lateral positions of the toys was switched across infants so that half the infants viewed the toy bunny on the right and the robot on the left first and half viewed the opposite arrangement first. Infants' looking time to the toys was measured to assess any baseline preferences. It was expected that infants would not show a significant preference for either toy. Infants' proportion of total looking time (PTLT) to the toy to be paired with the happy expression served as the dependent measure.

*Habituation.* Approximately one minute after the pretest, infants participated in an infant-controlled habituation procedure. Infants were randomly assigned to one of four habituation conditions manipulating affective contingency (presence or absence of contingency between the actress' affective response and the toys' movements) and gaze direction (congruence or incongruence between the actress' head and eye gaze direction and the location of the toys). Infants' ability to relate an emotional expression (e.g.,

happy versus fearful) with a particular toy (e.g., robot versus bunny) was tested by measuring infants' visual recovery to a switch in the affect-object pairing.

Infants viewed two filmed events, and each film depicted one toy (robot vs. bunny) paired with one affective expression (happy vs. fearful). During habituation, half the infants viewed the toy bunny paired with the happy expression and the toy robot paired with the fearful expression and the other half viewed the opposite pairing. The two affect-toy pairings were shown on alternating habituation trials. Half the infants received the bunny toy first and the robot second in an alternating pattern, whereas the other half received the opposite order. Infants viewed the alternating films for a minimum of six and a maximum of 20 infant-controlled trials. Each "trial" or stimulus event was presented until the infant looked away for 1.5 s or when the trial reached 60 s (maximum trial length). The average of the infant's looking times to the first two trials (baseline) was calculated. Once an infant decreased their looking time to the films by at least 50% of baseline for two consecutive trials, they were considered to have habituated to the films.

Following habituation, two no change post-habituation trials were presented. Infants' looking times to the post-habituation trials were compared with that of the habituation criterion in order to establish that infants actually habituated and to control for regression effects. If post-habituation looking was not less than criterion, infants were re-habituated, receiving additional habituation trials until the habituation criterion was

reached again. This ensured that all infants reached the habituation criterion before being presented with the test trials (affect-object pairing switch).

*Switch Test.* During the test trials, the affect-toy pairing was switched (reversed), so that if an infant was habituated to the bunny paired with a happy expression and the robot paired with a fearful expression, then the test trials depicted the robot paired with the happy expression and the bunny paired with the fearful expression. Thus, given that both toys and both affective expressions were shown during the test trials, the only novel aspect of the test trials was the affect-object *pairing*. It was expected that if infants detected the relationship between the affective expressions and the toys, they would show a significant visual recovery (increase in looking time) to the switch during the test trials (as compared to their looking time on the no change post-habituation trials). Trained observers unaware of the infant's condition recorded infants' visual fixations during the habituation phase. Inter-observer reliability was obtained for 25% of the participants.

*Visual Preference Posttest.* Approximately one minute following the habituation and switch test phase of the study, all infants were presented with both the 3-dimensional bunny and robot toys previously seen. An experimenter placed the toys on top of a tray covered with black cloth side by side in front of the infant for two 10 s trials. Then the experimenter covered the toys and switched the lateral position of the toys in between the trials, and uncovered the toys to begin the second trial (identical to the visual preference pretest). Again, infants' looking time to the toys was measured and PTLT to the toy paired with the happy expression served as the dependent variable.

*Manual Preference Test.* Immediately after the visual-preference posttest, an experimenter pushed the tray toward the infant so that the toys were within reach and the infants were given two 30 s trials to explore/play with the toys. Exactly as in the visual preference pre- and posttests, the experimenter covered the toys with black cloth for a few seconds in between trials and switched the lateral position of the toys before removing the cloth and commencing the second trial. The lateral positions of the toys was also counterbalanced across infants so that half the infants viewed the toy bunny on the right and the robot on the left first and half viewed the opposite arrangement first. Infants' frequency of touches and total time spent touching each toy was measured. Proportion of the total number of touches (PTNT), and proportion of total time spent touching (PTTT) the toy previously paired with the positive expression served as the dependent variables for the manual preference test. Touches were coded as any manual or oral contact with the toys.

## CHAPTER V

### RESULTS

#### *Visual Preference Pretest*

In order to assess any overall preferences for either the robot or bunny toys, single sample t-tests were conducted on infants' mean PTLTs to the toy to be paired with the positive expression (during subsequent habituation phase) against the chance value of 0.5 during the visual preference pretest. Infants showed no evidence of visually preferring the toy to be paired with the positive expression ( $M = .55$ ,  $SD = .23$  to the robot toy,  $p < .1$ ). Right and left looking preferences were also tested and revealed no significant effect ( $M = .54$ ,  $SD = .21$ , right side,  $p < .1$ ). Inter-observer reliability between trained observers on total looking time to each toy (for each trial) was calculated for 25% of the participants using a Pearson product-moment correlation. Inter-observer reliability averaged .92 ( $SD = .08$ ).

#### *Habituation and Switch Test*

Infants spent an average of 245.7 ( $SD = 151.2$ ) seconds viewing the filmed stimulus events. Inter-observer reliability between trained observers on looking time to each habituation trial was calculated for 25% of the participants using a Pearson product-moment correlation. Inter-observer reliability averaged .99 ( $SD = .12$ ). To examine the primary research question regarding the importance of contingency and gaze direction in infants' ability to relate the affective expressions with movements of the toys depicted in the stimulus films during the habituation phase, a 2 x 2 ANOVA was conducted on



infants' visual recovery scores with affective contingency (present vs. absent) and gaze direction (congruent gaze vs. incongruent gaze) as between-subjects factors. The results revealed a significant effect of contingency,  $F(1, 60) = 4.502, p = .038$ ; a significant effect of gaze direction,  $F(1, 60) = 4.115, p = .047$ , and no significant interaction,  $F(1, 60) = .387, p = .536$ . Infants in the contingent affect conditions had significantly greater visual recovery scores than infants in the noncontingent affect conditions,  $M = 3.71, SD = 7.96$  (contingent);  $M = -.56, SD = 8.42$  (noncontingent). Infants' visual recovery scores were significantly greater in the congruent gaze conditions than in the incongruent gaze conditions,  $M = 3.61, SD = 8.73$  (congruent gaze);  $M = -.46, SD = 7.67$  (incongruent gaze). In order to assess whether infants learned to relate the affective expressions and objects, single sample t-tests against the chance value of zero were conducted on visual recovery to the switch in affect-object pairings for each of the four habituation conditions. Figure 1 displays infants' mean visual recovery scores for each condition. Visual recovery to a change in affect-toy pairings was significantly greater than chance for infants in the contingent affect and congruent gaze condition,  $t(15) = 2.43, p = .028$ . Visual recovery scores for infants in all other conditions did not differ significantly from chance ( $ps > .1$ ).

Additionally, the number of infants who exhibited positive or negative visual recovery scores for each habituation condition was also examined using a non-parametric binomial test in order to assess whether the mean for each condition was carried by a few infants. Thirteen of 16 infants in the contingent affect and congruent gaze condition had

positive visual recovery scores ( $p = .02$ ), 10 of 16 infants in the contingent affect and incongruent gaze condition had positive visual recovery scores ( $p > .1$ ), 7 of 16 infants in the noncontingent affect and congruent gaze condition had positive visual recovery scores ( $p > .1$ ), and only 4 of 16 infants in the noncontingent affect and incongruent gaze condition had positive visual recovery scores ( $p = .08$ ). Thus, results at the individual subject level converged with group results indicating that infants in the contingent affect and congruent gaze condition detected the change in affect-object pairing, whereas infants in the other conditions did not.

Secondary analyses were also performed to assess any differences in interest level during the habituation trials as a function of affective contingency or gaze direction. A 2 x 2 ANOVA on affective contingency (present vs. absent) and gaze direction (congruent vs. incongruent) was conducted on initial interest level (baseline), and total looking time (number of seconds looking during habituation) to the habituation stimulus events. Results revealed no significant effects of either affective contingency or gaze direction ( $ps > .1$ ). Thus, infants' initial interest and overall looking time to the affect-object pairings did not differ as a function of contingency or gaze direction. Taken together, these results indicate that both contingency between affective expressions and toys' movements and congruence between head and eye gaze direction and the toys' location are important for young infants' detection of affect-object relations.

### *Visual Preference Posttest*

Overall, infants spent an average of 68% of the total exposure time looking at the 3-dimensional toys. In order to assess effects of contingency and gaze direction on infants' visual preferences for the toy previously paired with the positive expression, a 2 x 2 ANOVA on PTLT was conducted with affective contingency (present vs. absent) and gaze direction (congruent vs. incongruent) as between-subjects factors. Results revealed no significant effect of contingency or gaze direction, and no interaction ( $ps > .1$ ). To examine whether infants' PTLTs to the toy paired with the happy expression were significantly greater than chance, single sample t-tests were conducted on PTLT to the toy previously paired with the happy expression for each habituation condition. Results showed no significant PTLT for infants in any of the habituation conditions ( $ps > .1$ ). Further, mean PTLTs were compared for the pretest vs. posttest to assess whether infants increased looking to the toy paired with the happy expression during the posttest relative to looking to the toy to be paired with the happy expression during the pretest. Results revealed no significant shift in preference ( $ps > .1$  for all conditions) from pretest to posttest. Overall, the findings show no significant visual preferences for the toys paired with the happy expression.

### *Manual Preference Test*

On average, infants spent 62% of the total exposure time touching the 3-dimensional toys during the manual preference test. No significant preference for side of presentation was found ( $M = .53$ ,  $SD = .19$  for right side). Inter-observer reliability for

infants' frequency of touches and total time spent touching each toy during each manual preference trial was calculated using a Pearson product-moment correlation for 25% of the sample. Inter-observer reliability averaged .92 ( $SD = .14$ ) for frequency of touches and .93 ( $SD = .16$ ) for total time spent touching each toy. To address the second main research question regarding the role of contingency and gaze direction in influencing infants' social referencing skills, a 2 x 2 MANOVA on PTNT and PTTT was conducted with affective contingency (present vs. absent) and gaze direction (congruent vs. incongruent) as between-subjects factors. Results revealed a significant effect of contingency for both PTNT and PTTT,  $F(1, 60) = 5.263, p = .025$ ; and  $F(1, 60) = 4.35, p = .041$ , respectively, but no significant effect of gaze direction  $F(1, 60) = .021, p = .885$ ; and  $F(1, 60) = .189, p = .665$ , respectively, and no interaction  $F(1, 60) = .024, p = .877$ ; and  $F(1, 60) = .041, p = .841$ , respectively. Infants in the contingent affect conditions had significantly greater PTNT and PTTT than infants in the noncontingent affect conditions,  $M = .60, SD = .23$  (contingent);  $M = .45, SD = .28$  (noncontingent);  $M = .62, SD = .23$  (contingent);  $M = .48, SD = .31$  (noncontingent), respectively.

To assess whether infants demonstrated significant manual preferences for the toys paired with the happy expression, single sample t-tests were conducted on PTNT and PTTT to the toy previously paired with the happy expression for each habituation condition. Figures 2 and 3 display the means for each dependent measure. Results demonstrate that infants in the contingent affect and congruent gaze condition had marginally significant PTNT and significant PTTT to the toy paired with the positive

expression,  $t(15) = 2.08, p = .056$ ;  $t(15) = 2.65, p = .018$ , respectively. Infants in the contingent affect and incongruent gaze condition had PTTTs to the toy paired with the happy expression that did not reach the conventional significance level of .05, but did trend toward significance,  $t(15) = 1.675, p = .115$ . However, infants' PTNTs and PTTTs to the toy paired with the happy expression for all other habituation conditions did not reach significance,  $ps > .1$ . Taken together, these results indicate that contingency between a person's affective expressions and the movements of toys influenced infants' touching preferences for the toy previously paired with a positive expression.

Given these results, contingency between a person's expressions and the movements of toys was clearly important for detection of affect-object relations and for guiding manual preferences for objects paired with happy affective expressions. Gaze direction that was congruent with the toys' location also appears to have influenced detection of affect-object relations. However, gaze direction did not seem to influence infants' manual preferences for the toys previously paired with a happy expression. Thus, contingency plays an important role in infants' ability to learn to relate affective expressions and objects to which they refer and plays an important role in guiding infant manual explorations of 3-dimensional toys paired with a positive emotional expression. More research is needed to investigate the relative importance of gaze direction for infant detection of affect-object relations and for guiding infant exploratory behavior.

## CHAPTER VI

### DISCUSSION

The study assessed the role of contingency and gaze direction on young infants' ability to relate affective expressions with objects to which they refer, an early form of social referencing. A previous study examined the contexts that facilitate young infants' detection of affect-object relations and their subsequent manual preferences for objects and found that dynamic multimodal (audiovisual) contexts are critical for learning to relate affective expressions with objects as well as for guiding infant manual exploration of the objects (Vaillant-Molina & Bahrick, 2011). Although the previous study maximized the contingent relations between emotional expressions and the objects to which the expressions referred as well as gaze direction that was congruent with location of objects, the importance of these variables was not directly tested. The current study built upon these findings and tested the relative importance of temporal contingency between a person's affective expressions and the movements of toys to which the expressions refer and the relative importance of the congruence between a person's gaze direction with the location of moving toys. The findings support the predictions and indicate that contingency between a person's affective expressions and the movements of toys and congruence between a person's gaze direction and the location of toys influenced five- to six-month-old infants' ability to relate happy and fearful expressions with novel toys, although contingency appears to lead this influence. Furthermore, contingency played an important role in infants' subsequent touching preferences for the

the toys paired with the happy expression, demonstrating social referencing in early infancy.

### *Affective Contingency and Gaze Direction*

This study is the first to test the effects of contingency and head and eye gaze direction in young infants' perception of affect-object relations and their subsequent manual exploration of objects previously seen in a dynamic audiovisual social event. Contingencies yield information about what others will do next by emphasizing the temporal and causal relations between actions and their consequences. Infants are able to detect contingent relations between their own behaviors and their effects as well as detect contingent relations between environmental events and their consequences during early development. Indeed by five months of age, infants have had experience with contingent relations such as the temporal and spatial contingencies provided by visual and proprioceptive information when moving their legs and arms (Bahrick & Watson, 1985; Rochat & Morgan, 1995; Schmuckler, 1996), and detect contingent responsiveness provided by caregivers and experimenters during face-to-face interactions (Beebe, Jaffe, Markese, Buck, Chen, Cohen, Bahrick, Andrews, & Feldstein, 2010; Bigelow & DeCoste, 2003; Bigelow, MacLean, & McDonald 1996; Hains & Muir, 1996; Harrist & Waugh, 2002). Contingencies also provide useful and important information about which events are related to one another within the context of social affective events. Given that only infants in the contingent affect and congruent gaze condition detected a switch in affect-object pairings and showed touching preferences for the toy paired with the happy

expression, the findings suggest that contingency serves as a basis for relating affective expressions with objects in the natural world by highlighting the temporal and causal relations between affective expressions and the objects to which they refer.

The study also directly examined the importance of gaze direction for infants' perception of affect-object relations and subsequent manual preferences for objects based on the affective information depicted in dynamic events. Gaze direction is an important component skill for joint attention and social referencing, and was hypothesized to be important for detecting relations between affective expressions and objects to which the expressions refer in young infants, however, research indicates that this skill is not reliably seen until after the first six months of life. Although several studies indicate sensitivity to gaze information by three to six months (Morales, Mundy, & Rojas, 1998; Reid & Striano, 2005; Striano & Stahl, 2005) research on joint attention suggests there is considerable refinement of gaze detection, and gaze following over the first 12 months of age. However, less is known regarding infants' perception of gaze direction in audiovisual social events, and whether the ability to use gaze congruence is necessary for guiding infant manual exploration of objects in early development.

The present findings indicate that gaze direction did not influence subsequent touching preferences for toys paired with the happy affective expression. There was a main effect of affective contingency, no main effect of gaze direction, and no interaction of affective contingency and gaze direction on touching preferences for the toys paired with the happy expression. Infants in the contingent affect and congruent gaze condition



showed touching preferences for toys previously paired with the happy expression and infants in the contingent affect and incongruent gaze conditions showed marginal significance for touching preferences. However, gaze direction did appear to influence infant *detection* of affect-object relations. Only infants in the contingent affect and congruent gaze condition showed greater looking to the switch in affect-object pairings relative to the habituated events, whereas infants in the contingent affect and incongruent gaze condition showed no evidence of detecting the affect-object relations.

Interestingly, lack of evidence for detection of affect-object relations did not translate to a lack of touching preferences for toys paired with the positive expression during the subsequent manual preference test. That is, although infants in the contingent affect and incongruent gaze condition did not demonstrate they related the affective expressions with the toys during the habituation phase, they did prefer to touch the toys they had previously seen contingently paired with the happy facial and vocal expression, even though the gaze was incongruent with the toys' location (although with the sample size the result did not reach the conventional level of significance,  $p < .05$ ). Thus, contingency between affective expressions and toys' movements is necessary and sufficient for guiding infant manual exploration of objects in accordance with the affective expressions displayed in dynamic audiovisual events.

Given that contingency detection develops early in life it is likely that young infants use information about temporal contingencies earlier and more readily than they use gaze direction to guide their manual exploration of objects. Infants of five to six

months of age may be in a period of development during which gaze following skills are not sophisticated enough to guide manual behavior, and thus temporal contingency between affective expressions and objects outweighs other information in guiding their manual preferences for objects in the context of a social affective event.

### *Significance*

This study contributes to our understanding of detection of affect, affect-object relations, and behavior regulation based on affect-object relations in the context of dynamic affective events during early infancy and differs from other studies in several ways. First, most social referencing studies have tested infants of 12 to 18 months of age (Hornick & Gunnar, 1988; Kim, Walden, & Knieps, 2010; Martin, Witherington, & Edwards, 2008; Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme, Fernald, & Herrera, 1996; Vaish & Striano; Zabatany & Lamb, 1985), however, this study focused on the emergence of social referencing and tested infants in the first half year of life. Second, this study examined two important variables (contingency and gaze direction) in the emergence of social referencing in five- to six-month-old infants in order to better understand when and how infants' ability to detect affect-object relations emerges. In summary, contingency is a fundamental component skill for infant perception of affect-object relations and the emergence of social referencing. Furthermore, contingency appears to developmentally precede gaze direction in guiding manual exploration of objects in the context of a social referencing task. Future research is needed to further

investigate the roles of contingency and gaze direction and how they guide and constrain the development of affect perception throughout infancy.

## LIST OF REFERENCES

- Adamson, L. B. (1995). Joint attention, affect, and culture. In C. Moore, E. Phillip, & J. Durnham. *Joint attention: Its origins and role in development* (pp. 205-221). Hillsdale, NJ: Lawrence Erlbaum.
- Bahrnick, L. E. (1987). Infants' intermodal perception of two levels of temporal structure in natural events. *Infant Behavior and Development, 10*, 387-416.
- Bahrnick, L. E. (1988). Intermodal learning in infancy: Learning on the basis of two kinds of invariant relations in audible and visible events. *Child Development, 59*, 197-209.
- Bahrnick, L.E. (1992). Infants' perceptual differentiation of amodal and modality-specific audio-visual relations. *Journal of Experimental Child Psychology, 53*, 180-199.
- Bahrnick, L. E. (1994). The development of infants' sensitivity to arbitrary intermodal relations. *Ecological Psychology, 6*, 111-123.
- Bahrnick, L. E. (2002). Generalization of learning in three-and-a-half-month-old infants on the basis of amodal relations. *Child Development, 73*, 667-681.
- Bahrnick, L. E., Flom, R., & Lickliter, R. (2002). Intersensory redundancy facilitates discrimination of tempo in 3-month-old infants. *Developmental Psychobiology, 41*, 352-363.
- Bahrnick, L. E., Hernandez-Reif, M., & Flom, R. (2005). The development of infant learning about specific face-voice relations. *Developmental Psychology, 41*, 541-552.
- Bahrnick, L.E., & Lickliter, R. (2000). Intersensory redundancy guides attentional selectivity and perceptual learning in infancy. *Developmental Psychology, 96*, 190-201.
- Bahrnick, L.E., & Lickliter, R. (2002). Intersensory redundancy guides early perceptual and cognitive development. In R. Kail (Ed.), *Advances in child development and behavior* (Vol 30, pp. 153-187). New York: Academic Press.
- Bahrnick, L.E., & Lickliter, R. (2004). Infants' perception of rhythm and tempo in unimodal and multimodal stimulation: a developmental test of the intersensory redundancy hypothesis. *Cognitive, Affective, and Behavioral Neuroscience, 4*, 137-147.
- Bahrnick, L. E., & Watson, J. S. (1985). Detection of intermodal proprioceptive-visual

- contingency as a potential basis of self-perception in infancy. *Developmental Psychology*, 21, 963-973.
- Bakeman, R., & Adamson, L. (1984). Coordinating attention to people and objects in mother-infant and peer-infant interactions. *Child Development*, 55, 1278-1289.
- Baldwin, D. A. (1995). Understanding the link between joint attention and language. In C. Moore and P. Dunham (Eds.), *Joint attention: Its role and development* (pp. 131-158). Hillsdale, NJ: Lawrence Erlbaum.
- Barrera, M. E., & Maurer, D. (1981). The perception of facial expressions by three-month-old infants. *Child Development*, 52, 203-206.
- Beebe, B., Jaffe, J., Markese, S., Buck, K., Chen, H., Cohen, P., Bahrnick, L. E., Andrews, H., & Feldstein, S. (2010). The origins of 12-month attachment: A microanalysis of four-month mother–infant interaction. *Attachment & Human Development*, 12, 3-141.
- Bigelow, A. E., & DeCoste, C. (2003). Sensitivity to social contingency from mothers and strangers in 2-, 4-, and 6-month-old infants. *Infancy*, 4, 111-140.
- Bigelow, A. E., MacLean, B. K., & McDonlad, D. (1996). Infants' response to live and replay interaction with self and mother. *Merrill-Palmer Quarterly*, 42(2), 596-611.
- Boccia, M., & Campos, J. J. (1989). Maternal emotional signals, social referencing, and infants' reactions to strangers. In N. Eisenberg (Ed.), *Empathy and related emotional responses: New directions for child development* (pp.25-49). San Francisco: Jossey-Bass.
- Bornstein, M. H., & Arterberry, M. E. (2003). Recognition, discrimination and categorization of smiling by five-month-old infants. *Developmental Science*, 6, 585-599.
- Butterworth, G. (1995). Factors in visual attention and eliciting manual pointing in human infancy. In Rotiblat H. L. & Mayer J. (Eds.), *Comparative approaches to cognitive science* (pp. 329-338). Cambridge, MA: MIT Press.
- Campos, J. & Sternberg, C. (1981). Perception, appraisal, and emotion: The onset of social referencing. In M. Lamb & L. Sherrod (Eds.), *Infant social cognition: Empirical and theoretical considerations* (pp. 273-314). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Camras, L. A., & Sachs, V. B. (1991). Social referencing and caretaker expressive behavior in a day care setting. *Infant Behavior and Development*, 14, 27-36.

- Caron, A. J., Caron, R. F., & McLean, D. J. (1988). Infant discrimination of naturalistic emotional expressions: The role of face and voice. *Child Development, 59*, 604-616.
- Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence. *Monographs of the Society of Research in Child Development, 36* (4, Serial No. 176).
- Corkum, V., & Moore, C. (1998). The origins of joint attention in infancy. *Developmental Psychology, 34*, 28-38.
- D'Entremont, B. (2000). A perceptual-attentional explanation of gaze following in three- and six-month-olds. *Developmental Science, 3*, 302-311.
- D'Entremont, B., Hains, S. M. J., & Muir, D. W. (1997). A demonstration of gaze following in 3- to 6-month-olds. *Infant Behavior and Development, 20*, 569-572.
- Dunham, P. J., & Moore, C. (1995). Current themes in research of joint attention. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp.15-28). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Ellsworth, C. P., Muir, D. W., & Hains, S. M. J. (1993). Social competence and person-object differentiation: An analysis of the still-face effect. *Developmental Psychology, 29*, 63-73.
- Fantz, R. (1963). Pattern vision in newborn infants. *Science, 140*, 286-297.
- Fantz, R. (1964). Visual experience in infants: Decreased attention to familiar patterns relative to novel ones. *Science, 146*, 668-670.
- Feinman, S. (1982). Social referencing in infancy. *Merrill-Palmer Quarterly, 28*, 445-470.
- Feinman, S., & Lewis, M. (1983). Social referencing at ten months: A second-order effect on infants' responses to strangers. *Child Development, 54*, 878- 887.
- Field, T., Healy, B. T., Goldstein, S., & Guthertz, M. (1990). Behavior-state matching and synchrony in mother-infant interactions of nondepressed versus depressed dyads. *Developmental Psychology, 26*, 7-14.
- Flom, R., & Bahrick, L.E. (2007). The development of infant discrimination of affect in multimodal and unimodal stimulation: The role of intersensory redundancy. *Developmental Psychology, 43*, 238-252.

- Flom, R., & Johnson, S. (in press). The effects of adults' affective expressions and direction of visual gaze on 12-month-olds' visual preferences for an object following a 5-minute, 1-day, or 1-month delay. *British Journal of Developmental Psychology*.
- Flom, R., & Pick, A. D. (2005). Experimenter affective expression and gaze following in seven-month-old infants. *Infancy, 7*, 207-218.
- Gewirtz, J. L., & Pelaez-Nogueras, M. (1992). Social referencing as a learned process. In S. Feinman (Ed.). *Social referencing and the social construction of reality in infancy* (pp. 151-173). New York: Plenum.
- Gibson, E. J. (1969). *Principles of perceptual learning and development*. East Norwalk, CT: Appleton-Century-Crofts.
- Gogate, L. J., & Bahrick, L. E. (1998). Intersensory redundancy facilitates learning of arbitrary relations between vowel sounds and objects in 7-month-old infants. *Journal of Experimental Child Psychology, 69*, 133-149.
- Gunnar, M., & Stone, C. (1984). The effects of positive maternal affect on infants responses to pleasant, ambiguous, and fear-provoking toys. *Child Development, 55*, 1231-1236.
- Hains, S. M. J., & Muir, D. W. (1996). Effects of stimulus contingency in infant-adult interactions. *Infant Behavior and Development, 19*, 49-61.
- Harrist, A. W., & Waugh, R. M. (2002). Dyadic synchrony: Its structure and function in children's development. *Developmental Review, 22*, 555-592.
- Haviland, J. M., & Lelwica, M. (1987). The induced affect response: Ten-week-old infants' responses to three emotion expressions. *Developmental Psychology, 23*, 97-104.
- Hayne, H., Greco-Vigorito, C. & Rovee-Collier, C. (1993). Forming contextual categories in infancy. *Child Development, 8*, 63-82.
- Hayne, H., Gross, J., Hildreth, K., & Rovee-Collier, C. (2000). Repeated reminders increase the speed of memory retrieval of 3-month-old infants. *Developmental Science, 3*, 312-318.
- Hertenstein, M. J. & Campos, J. J. (2004). The retention effects of an adult's emotional displays on infant behavior. *Child Development, 75*, 595-693.
- Hood, B. M., Willen, D., & Driver, J. (1998). Adult's eyes trigger shifts of visual attention in human infants. *Psychological Science, 9*, 131-134.

- Hornick, R., & Gunnar, M. (1988). A descriptive analysis of infant social referencing. *Child Development, 59*, 626-634.
- Hornick, R., Risenhoover, N., & Gunnar, M. (1987). The effects of maternal positive, neutral, and negative affective communications on infant responses to new toys. *Child Development, 58*, 937-944.
- Horowitz, F. D., Paden, L., Bhana, K., & Self, P. (1972). An infant-control procedure for studying infant visual fixations. *Developmental Psychology, 7*, 90-101.
- Kahana-Kalman, R., & Walker-Andrews, A. S. (2001). The role of person familiarity in young infants' perception of emotional expressions. *Child Development, 72*, 352-369.
- Kestesbaum, R., & Nelson, C. A. (1990). The recognition and categorization of upright and inverted expressions by 7-month-old infants. *Infant Behavior and Development, 13*, 497-511.
- Kim, G., Walden, T. A., & Knieps, L. J. (2010). Impact and characteristics of positive and fearful emotional messages during infant social referencing. *Infant Behavior and Development, 33*, 189-195.
- Klennert, M. (1984). The regulation of infant behavior by maternal facial expression. *Infant Behavior and Development, 7*, 447-465.
- Klennert, M. D., Emde, R. N., Butterfield, P. & Campos, J. J. (1986). Social referencing: The infant's use of emotional signals from a friendly adult with mother present. *Developmental Psychology, 22*, 427-432.
- Kuchuk, A., Vibbert, M., & Bornstein, M. H. (1986). The perception of smiling and its experiential correlates in three-month-old-infants. *Child Development, 57*, 1054-1061.
- LaBarbera, J. D., Izard, C. E., Vietze, P., & Parisi, S. A. (1976). Four- and six-month-old infants' visual responses to joy, anger, and neutral expressions. *Child Development, 47*, 535-538.
- Lickliter, R., Bahrick, L.E., & Honeycutt, H. (2002). Intersensory redundancy facilitates perceptual learning in bobwhite quail embryos. *Developmental Psychology, 38*, 15-23.
- Ludemann, P. M. (1991). Generalized discrimination of positive facial expressions by seven- and ten-month-old infants. *Child Development, 62*, 55-67.



- Martin, N. G., Witherington, D. C., & Edwards, A. (2008). The development of affect specificity in infants' use of emotion cues. *Infancy, 13*(5), 456-468.
- Melinder, A. Forbes, D., Tronick, D., Fikke, L., & Gredeback, G. (2010). The development of the still-face effect: Mothers do matter. *Infant Behavior and Development, 33*, 472-481.
- Montague, D. P. F., & Walker-Andrews, A. S. (2001). Peekaboo: A new look at infants' perception of emotion expressions. *Developmental Psychology, 37*, 826-838.
- Morales, M., Mundy, P., Crowson, M. M., Neal, A. R., & Delgado, E. F. (2005). Individual differences in infant attention skills, joint attention, and emotion regulation behavior. *International Journal of Behavioral Development, 29*(3), 259-263.
- Morales, M., Mundy, P., & Rojas, J. (1998). Following the direction of gaze and language development in six-month-olds. *Infant Behavior and Development, 21* (2), 373-377.
- Moses, L., Baldwin, D., Rosicky, J., & Tidball, G. (2001). Evidence for referential understanding in the emotions domain at twelve and eighteen months. *Child Development, 72*, 718-735.
- Muir, D. W., & Hains, S. M. J. (1993). Infant sensitivity to perturbations in adult facial, vocal, tactile, and contingent stimulation during face-to-face interactions. In B. de Boysson-Bardies, S. de Schonen, P. Juszyk, P. MacNeilage, & J Morton (Eds.), *Developmental neurocognition: Speech and face processing in the first year of life* (pp. 171-185). Dordrecht, The Netherlands: Kluwer Academic.
- Mumme, D. L. & Fernald, A. (2003). The infant as onlooker: Learning from emotional reactions to observed in a television scenario. *Child Development, 74*, 221-237.
- Mumme, D. L., Fernald, A., & Herrera, C. (1996). Infants' responses to facial and vocal emotional signals in a social referencing paradigm. *Child Development, 67*, 3219-3237.
- Murray, L., & Trevarthen, C. (1985). Emotional regulation of interaction between two-month-olds and their mothers. In T. M. Field & N. A. Fox (Eds.). *Social perception in infants* (pp. 101-125). Norwood, NJ: Ablex.
- Nelson, C. A., Morse, P. A. & Leavitt, L. A. (1979). Recognition of facial expressions by seven-month-old infants. *Child Development, 50*, 1239-1242.
- Pelaez, M., Virues-Ortega, J., & Gewirtz, J. L. (in press). Acquisition of social

- referencing via discrimination training in four- and five-month-old infants. *Journal of Applied Behavior Analysis*.
- Pelaez-Nogueras, M., Field, T., Hossain, Z., Pickens, J. (1996). Depressed mothers' touching increases infants' positive affect and attention in a still-face interactions. *Child Development, 67*, 1780-1792.
- Pelaez-Nogueras, M., Gewirtz, J. L., Field, T., Cigales, M., Malphurs, J., Clasky, S., & Sanchez, A. (1996). Infants' preference for touch stimulation in face-to-face interactions. *Journal of Applied Developmental Psychology, 17*, 199-213.
- Reid, V. M., & Striano, T. (2005). Adult gaze influences infant attention and object processing: Implications for cognitive neuroscience. *European Journal of Neuroscience, 21*, 1763-1766.
- Rochat, P., & Morgan, R. (1995). Spatial determinants in the perception of self-produced leg movements in 3- to 5-month-old infants. *Developmental Psychology, 31*, 626-636.
- Rochat, P., & Striano, T. (1999). Social cognitive development in the first year. In P. Rochat (Ed.). *Early social cognition: Understanding others in the first few months of life* (pp. 3-34). Mahwah, NJ: Lawrence Erlbaum Associates.
- Schmuckler, M. A. (1996). Visual-proprioceptive intermodal perception in infancy. *Infant Behavior and Development, 19*, 221-232.
- Schwartz, G. M., Izard, C. E. & Ansul, S. E. (1985). The 5-month-old's ability to discriminate facial expressions of emotion. *Infant Behavior & Development, 8*, 65-77.
- Serrano, J. M., Iglesias, J. & Loeches, A. (1992). Visual discrimination and recognition of facial expressions of anger, fear, and surprise in four- to six-month-old infants. *Developmental Psychobiology, 25*, 411-425.
- Soken, N. H., & Pick, A. D. (1992). Intermodal perception of happy and angry expressive behaviors by seven-month-old infants. *Child Development, 63*, 787-795.
- Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: Its effects on the visual cliff behavior of one-year-olds. *Developmental Psychology, 21*, 195-200.
- Spelke, E. S. (1976). Infants' intermodal perception of events. *Cognitive Psychology, 8*, 553-560.

- Stern, D. N., Hofer, L., Haft, W., & Dore, J. (1985). Affect attunement: The sharing of feeling states between mother and infant by means of intermodal fluency. In T. M. Field & N. A. Fox (Eds.), *Social perception in early infancy* (pp. 249-268). Norwood, NJ: Ablex.
- Striano, T., & Bertin, E. (2005a). Relation among joint attention skills in five- to ten-month-old infants. *British Journal of Developmental Psychology*, *23*, 1–11.
- Striano, T., & Bertin, E. (2005b). Coordinated affect with mothers and strangers: A longitudinal study of joint attention between five and nine months of age. *Cognition and Emotion*, *19*, 781-890.
- Striano, T. & Rochat, P. (2000). Emergence of selective social referencing in infancy. *Infancy*, *2*, 253-264.
- Striano, T. & Stahl, D. (2005). Sensitivity to triadic attention in early infancy. *Developmental Science*, *8*, 333-343.
- Tarabulsky, G. M., Tessier, R., & Kappas, A. (1996). Contingency detection and the contingent organization of behavior in interactions: Implications for socioemotional development in infancy. *Psychological Bulletin*, *120*, 25-41.
- Tomasello, M. (1995). Joint attention as social cognition. In C. Moore, & P. Dunham (Eds.), *Joint attention: Its origin and role in development* (pp. 103–130). Hillsdale, NJ: Lawrence Erlbaum.
- Vaillant, M. & Bahrick, L. E. (2003, April). *Five-month-old infants match facial and vocal expressions of other infants*. Presented at the Society for Research in Child Development, Tampa, FL.
- Vaillant-Molina, M., & Bahrick, L. E. (2011). The role of intersensory redundancy in the emergence of social referencing in 5 ½-month old infants. *Developmental Psychology*. Advance online publication. doi: 10.1037/a0025263
- Vaish, A., & Striano, T. (2004). Is visual reference necessary? Contributions of facial versus vocal cues in 12-month-olds' social referencing behavior. *Developmental Science*, *7*, 261-269.
- Walden, T. A., & Baxter, A. (1989). The effects of context and age on social referencing. *Child Development*, *61*, 1511-1518.
- Walden, T. A., & Ogan, T. A. (1988). The development of social referencing. *Child Development*, *59*, 1230-1240.

- Walker, A. S. (1982). Intermodal perception of expressive behaviors by human infants. *Journal of Experimental Child Psychology*, 33, 514-535.
- Walker-Andrews, A. S. (1986). Intermodal perception of expressive behaviors: Relation of eye and voice? *Developmental Psychology*, 22, 373-377.
- Walker-Andrews, A. S. (1988). Infants' perception of the affordances of expressive behaviors. In C. K. Rovee-Collier (Ed.), *Advances in infancy research* (pp. 173-221). Norwood, NJ: Ablex.
- Walker-Andrews, A. S. (1997). Infants' perception of expressive behaviors: Differentiation of multimodal information. *Psychological Bulletin*, 121, 437-456.
- Walker-Andrews, A. S., & Grolnick, W. (1983). Discrimination of vocal expression by young infants. *Infant Behavior and Development*, 6, 491-498.
- Walker-Andrews, A. S., & Lennon, E. (1991). Infants' discrimination of vocal expressions: Contributions of auditory and visual information. *Infant Behavior and Development*, 14, 131-142.
- Werker, J. F., Cohen, L. B., Loyd, V. L., Casasola, M., & Stager, C. L. (1998). Acquisition of word-object associations in 14-month-old infants. *Developmental Psychology*, 34, 1289-1309.
- Wilcox, B., & Clayton, F. (1968). Infant visual fixation on motion pictures of the human face. *Journal of Experimental Child Psychology*, 6, 22-32.
- Zarbatany, L., & Lamb, M. (1985). Social referencing as a function of information source: Mothers versus strangers. *Infant Behavior and Development*, 8, 25-33.

Table 1

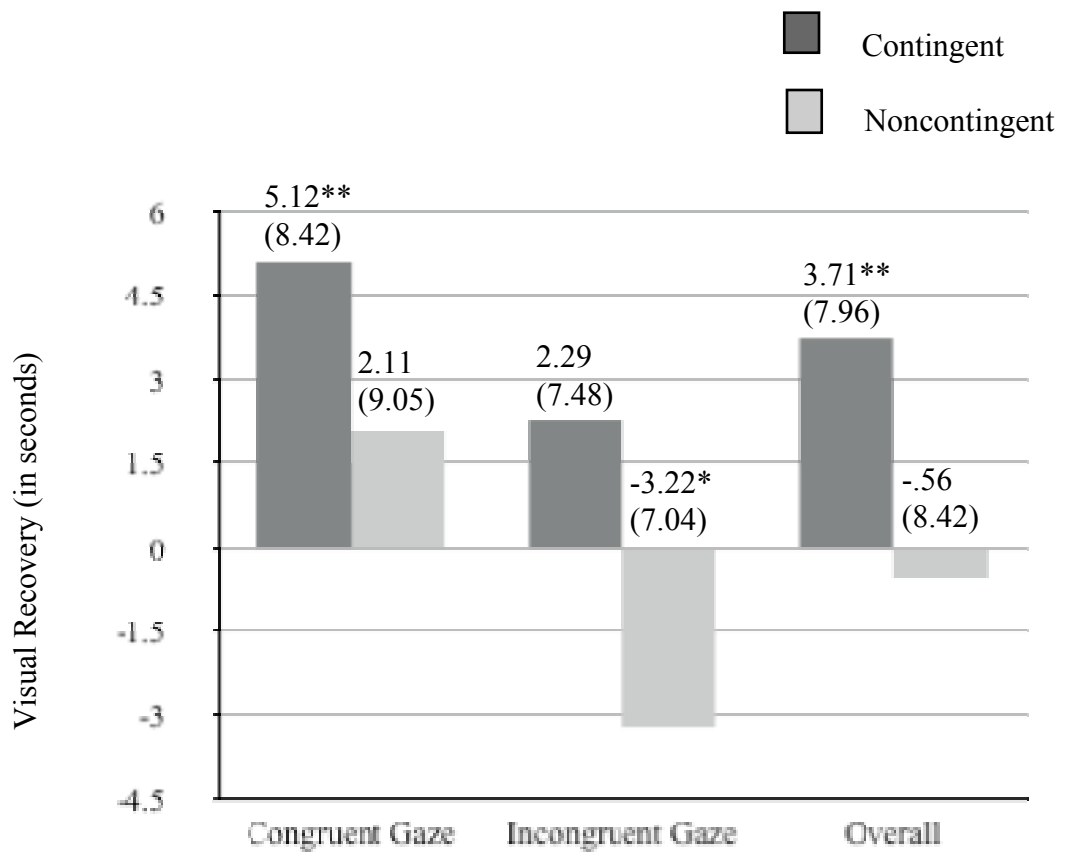
*Study Procedure: Trial Structure, Stimuli, Conditions, and Dependent Variables for All Phases*

|                     | <b>Phases</b>                        |   |                                       |  |
|---------------------|--------------------------------------|---|---------------------------------------|--|
|                     | <u>Visual Preference<br/>Pretest</u> | <u>Habituation &amp;<br/>Switch Test</u>  | <u>Visual Preference<br/>Posttest</u> | <u>Manual<br/>Preference Test</u>        |
| Trial Structure     | 2 10-s trials                        | 6 to 20 infant controlled trials  | 2 10-s trials                         | 2 30-s trials                            |
| Stimuli             | 3-D toys side by side                | Alternating films of 2 toys each paired with 1 affective expression   | 3-D toys side by side                 | 3-D toys side by side                    |
| Conditions          | Unimodal visual (N=64)               | Contingent Affect & Congruent Gaze (N=16);<br>Contingent Affect & Incongruent Gaze (N=16);<br>Noncontingent Affect & Congruent Gaze (N=16);<br>Noncontingent Affect & Incongruent Gaze (N=16) | Unimodal visual (N=64)                | Visual and tactile (N=64)                |
| Dependent Variables | PTLT to each toy                     | Visual recovery to switch in affect-object pairing  | PTLT to each toy                      | PTNT & PTTT toy paired with happy affect |

*Note:* PTLT is the proportion of total looking time, PTNT is the proportion of total number of touches, and PTTT is the proportion of total time spent touching the toy. The lateral position of the toys was counterbalanced across trials and across infants. The affect-toy pairing was counterbalanced across infants.

Figure 1

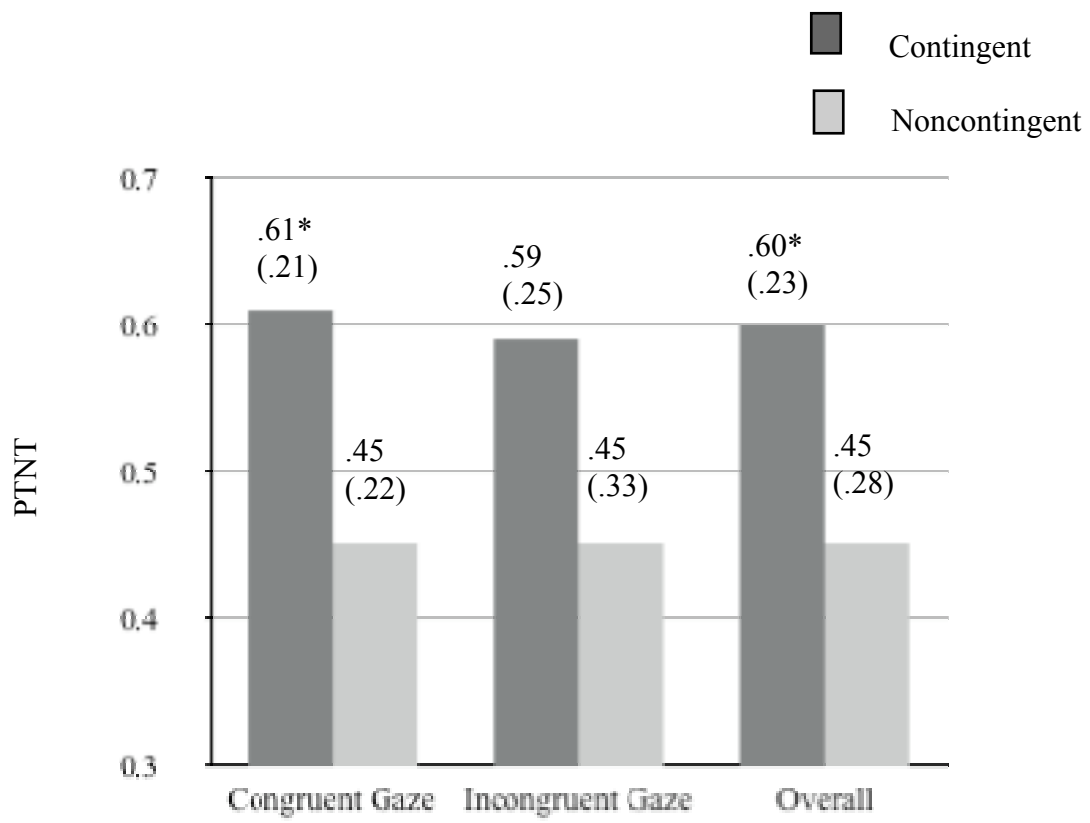
*Habituation and Switch Test: Visual Recovery to a Change in Affect-Object Pairing for Congruent Gaze (N = 32) and Incongruent Gaze (N = 32) as a Function of Affective Contingency*



\*  $p < .1$   
\*\*  $p < .05$

Figure 2

*Manual Preference Test: Proportion of Total Number of Touches (PTNT) to the Toy Previously Paired with the Happy Expression for Congruent Gaze (N = 32) and Incongruent Gaze (N = 32) as a Function of Affective Contingency*



\*  $p \leq .1$

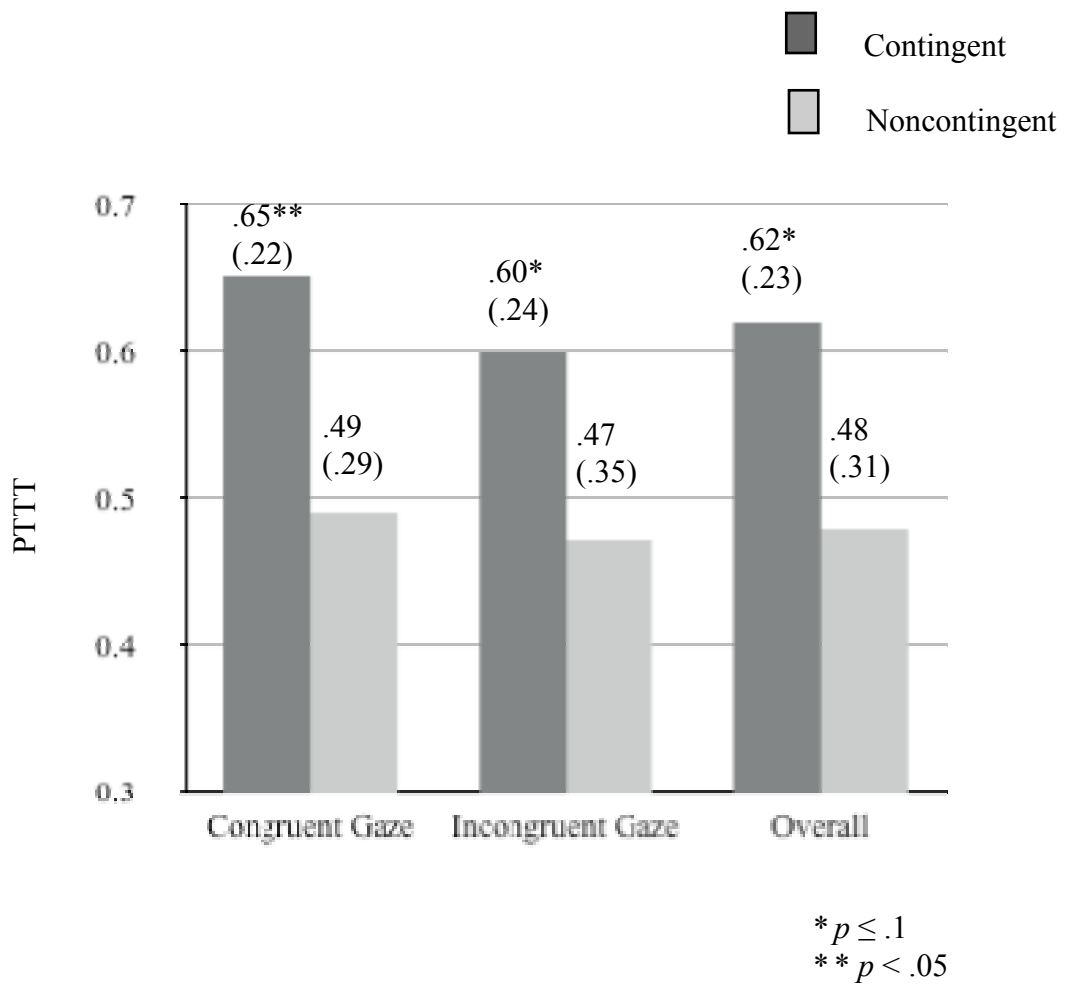
\*\*  $p < .05$

Figure 3

*Manual Preference Test: Proportion of Total Time Spent Touching the Toy (PTTT)*

*Paired with the Happy Expression for Congruent Gaze (N = 32) and Incongruent Gaze*

*(N = 32) as a Function of Affective Contingency*





## VITA

### MARIANA VAILLANT MOLINA

- 1997-2001                      B.A. Psychology  
Florida International University  
Miami, FL
- 2002-2007                      M.S. Psychology  
Florida International University  
Miami, FL
- 2004-2008                      Fellowship Award  
Minority Biomedical Research Support (MBRS/RISE)
- 2007-2011                      Doctoral Candidate  
Florida International University  
Miami, FL

### SELECTED PUBLICATIONS AND PRESENTATIONS

- Bahrnick, L.E., Lickliter, R., Castellanos, I., & Vaillant-Molina, M. (2010). Increasing task difficulty enhances effect of intersensory redundancy: Testing a new prediction of the intersensory redundancy hypothesis. *Developmental Science, 13*, 731-737.
- Bahrnick, L.E., Todd, J.T., Vaillant-Molina, M. (2011, March). *A new measure for assessing four fundamental aspects of attention: The multisensory attention assessment protocol (MAAP)*. Society for Research in Child Development, Montreal, Quebec, Canada.
- Bahrnick, L.E., Todd, J.T., Vaillant-Molina, M., Sorondo, B.M., Castellanos, I., & Argumosa, M. (2009, March). *Development of basic indices of attention to nonsocial events: Effects of unimodal versus bimodal stimulation*. Society for Research in Child Development, Denver, CO.
- Bahrnick, L.E., Todd, J.T., Vaillant-Molina, M., Sorondo, B.M., & Ronacher, C.R. (2010, May). *Impaired detection of temporal synchrony for social and non-social events in children with autism spectrum disorder*. International Meeting for Autism Research, Philadelphia, PA.
- Bahrnick, L. E., Vaillant-Molina, M., Shuman, M. A., Batista, L. C., Newell, L. C., Castellanos, I., & Williams, T. (2005, July). *The salience of actions over faces for young infants*. International Conference on Perception and Action, Montorey, CA.

- Bahrick, L.E., Vaillant-Molina, M., Shuman, M., Castellanos, I., Batista, L.C., & Werhahn, M. (2005, April). *The role of multisensory information in infant attention to faces of speakers versus rhythm of speech*. Society for Research in Child Development, Atlanta, GA.
- Castellanos, I., Vaillant-Molina, M., Lickliter, R. & Bahrick, L.E. (2006, October). *Intersensory redundancy educates infants' attention to amodal information in unimodal stimulation*. International Society of Developmental Psychobiology Annual Meeting, Atlanta, GA.
- Vaillant, M. & Bahrick, L. E. (2003, April). *Five-month-old infants match facial and vocal expressions of other infants*. Society for Research in Child Development, Tampa, FL.
- Vaillant-Molina, M. & Bahrick, L. E. (2005, May). *Infants' perception of object-affect relations*. Society for Research in Child Development, Atlanta, GA.
- Vaillant-Molina, M. & Bahrick, L. E. (2007, March). *Detection of multimodal affect-object relations guides young infants manual exploration of objects*. Society for Research in Child Development, Boston, MA.
- Vaillant-Molina, M., & Bahrick, L.E. (2011). The role of intersensory redundancy in the emergence of social referencing in 5 ½-month-old infants. *Developmental Psychology*. Advance online publication. doi: 10.1037/a0025263
- Vaillant-Molina, M., Gutierrez, M. E., & Bahrick, L. E. (2005, November). *Infant memory for modality-specific properties of contingent and noncontingent events: The role of intersensory redundancy in self perception*. International Society of Developmental Psychobiology, Washington, DC.
- Vaillant-Molina, M., Ibanez, L. V., Messinger, D. S., & Bahrick, L. E. (2005, July). *Young infants' perception of emotional expressions of other infants*. International Society for Research on Emotion Conference, Bari, Italy.
- Vaillant-Molina, M., Newell, L., Castellanos, I., Bahrick, L.E., & Lickliter, R. (2006, June). *Intersensory redundancy impairs face perception in early development*. International Conference on Infant Studies, Kyoto, Japan.